

Central Radio Propagation Laboratory

IONOSPHERIC PREDICTIONS

*for
March
1964*

TB 11-499-12/TO 31-3-28



U.S. DEPARTMENT of COMMERCE
National Bureau of Standards
Number 12/Issued December 1963

U.S. DEPARTMENT OF COMMERCE

Luther H. Hodges, Secretary



NATIONAL BUREAU OF STANDARDS

A. V. Astin, Director

Central Radio Propagation Laboratory

Ionospheric Predictions

for March 1964

[Formerly "Basic Radio Propagation Predictions," CRPL Series D.]

Number 12

Issued

December 1963

The CRPL Ionospheric Predictions are issued monthly as an aid in determining the best sky-wave frequencies over any transmission path, at any time of day, for average conditions for the month. Issued three months in advance, each issue provides tables

of numerical coefficients that define the functions describing the predicted worldwide distribution of foF2 and M(3000)F2 and maps for each even hour of universal time of MUF(Zero)F2 and MUF(4000)F2.

NOTE: Department of Defense personnel see back cover.

Use of funds for printing this publication approved by the Director of the Bureau of the Budget (June 19, 1961).

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402. Price 15 cents.

Annual subscription (12 issues) \$1.50 (50 cents additional for foreign mailing).

National Bureau of Standards

The functions of the National Bureau of Standards are set forth in an Act of Congress, March 3, 1901, as amended. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and tech-

nical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. The Bureau also serves as the Federal technical research center in a number of specialized fields.

Central Radio Propagation Laboratory

The Central Radio Propagation Laboratory at Boulder, Colorado, is the central agency of the Federal Government for the collection, analysis, and dissemination of information on propagation of radio waves at all frequencies along the surface of the earth, in the atmosphere, and in space, and performs scientific studies looking toward new techniques for the efficient use and conservation of the radio spectrum. To carry out this responsibility, the CRPL—

1. Acts as the central agency for the conduct of basic research on the nature of radio waves, the pertinent properties of the media through which radio waves are transmitted, the interaction of radio waves with those media, and on the nature of radio noise and interference effects. This includes compilation of reports by other foreign and domestic agencies conducting research in this field and furnishing advice to government and nongovernment groups conducting propagation research.

2. Performs studies of specific radio propagation mechanisms and performs scientific studies looking

toward the development of techniques for efficient use and conservation of the radiofrequency spectrum as part of its regular program or as requested by other government agencies. In an advisory capacity, coordinates studies in this area undertaken by other government agencies.

3. Furnishes advisory and consultative service on radio wave propagation, on radiofrequency utilization, and on radio systems problems to other organizations within the United States, public and private.

4. Prepares and issues predictions of radio wave propagation and noise conditions and warnings of disturbances in these conditions.

5. Acts as a central repository for data, reports, and information in the field of radio wave propagation.

6. Performs scientific liaison and exchanges data and information with other countries to advance knowledge of radio wave propagation and interference phenomena and spectrum conservation techniques, including that liaison required by international responsibilities and agreements.

Introduction

The "Central Radio Propagation Laboratory Ionospheric Predictions" is the successor to the former "Basic Radio Propagation Predictions," CRPL Series D. To make effective use of these predictions, National Bureau of Standards Handbook 90, "Handbook for CRPL Ionospheric Predictions Based on Numerical Methods of Mapping," should be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, price 40 cents. This Handbook includes required additional data, nomographs and graphical aids, as well as methods for the use of the predictions. The Handbook supersedes the obsolete NBS Circular 465.

The basic prediction appears in tables 1 and 2, presenting predicted coefficients for f_oF_2 and $M(3000)F_2$ defining the numerical map functions describing the predicted worldwide variation of these characteristics. With additional auxiliary information, these coefficients may be used as input data for electronic computer programs solving specific high frequency propagation problems. The basic equations, their interpretation, and methods of using the numerical maps are described in two papers by W. B. Jones and R. M. Gallet, "The Representation of Diurnal and Geographic Variations of Ionospheric Data by Numerical Methods," Volume 66D, Number 4, July-August 1962, pages 419-438, and "Methods for Applying Numerical Maps of Ionospheric Characteristics," Volume 66D, Number 6, November-December 1962, pages 649-662, both in the Journal of Research of the National Bureau of Standards, Section D. Radio Propagation. The predicted numerical map coefficients of tables 1 and 2 may be purchased in the form of a tested set of punched cards. Write to the Prediction Services Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado, to arrange for the purchase of the set of punched cards and for further information and assistance in the application of computer methods and numerical prediction maps to specific propagation problems.

The graphical prediction maps, derived from the basic prediction, are provided for those unable to make use of an electronic computer. Figures 1 to 12 present world maps of MUF (Zero) F_2 and MUF (4000) F_2 for each even hour of universal time. Figures 13 to 16 present the same predictions for hours 00 and 12 universal time for the North and South Polar areas. Predicted polar maps for each even hour of universal time may be obtained by special arrangements with the Central Radio Propagation Laboratory. Handbook 90 describes methods for including regular E- F_1 propagation. Figure A is a graph of predicted and observed Zürich sunspot numbers which shows the recent trend of solar activity. Table A lists observed and predicted Zürich smoothed relative sunspot numbers and includes the sunspot number used for the current prediction.

Members of the U.S. Army, Navy, or Air Force desiring the Handbook and the Ionospheric Predictions should send requests to the proper service address; for the Navy: The Director, Naval Communications, Department of the Navy, Washington, D.C., 20350; for the Air Force: Directorate of Command Control and Communications, Headquarters, United States Air Force, Washington, D.C., 20330. Attention: AFOCCAA. Army personnel should refer to the Handbook as TM-11-499 and to the monthly predictions as TB 11-499-(), predictions for the month of March 1964 being distributed in December 1963 and designated TB 11-499-(12), and should requisition these through normal publication channels.

Information concerning the theory of radio wave propagation and such important problems as absorption, field intensity, lowest useful high frequencies, etc., is given in National Bureau of Standards Circular 462, "Ionospheric Radio Propagation." A revised work is in preparation which will be announced in the Ionospheric Prediction series when available. Additional information about radio noise may be found in C.C.I.R. Report Number 65, "Revision of Atmospheric Noise Data," International Telecommunication Union, Geneva, 1957.

Reports to this Laboratory of experience with these predictions would be appreciated. Correspondence should be addressed to the Prediction Services Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado.

Table A

Observed and Predicted Zurich Smoothed Relative
Sunspot Numbers

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1952	43 (53)	42 (51)	39 (52)	36 (52)	34 (52)	32 (52)	31 (51)	29 (49)	28 (46)	28 (43)	27 (38)	26 (33)
1953	24 (30)	22 (29)	20 (27)	19 (24)	17 (22)	15 (21)	13 (20)	12 (18)	11 (18)	10 (17)	9 (16)	7 (15)
1954	6 (14)	6 (12)	4 (11)	3 (10)	4 (10)	4 (9)	5 (8)	7 (8)	8 (8)	8 (10)	10 (10)	12 (11)
1955	14 (12)	16 (14)	20 (14)	23 (13)	29 (16)	35 (18)	40 (22)	46 (27)	55 (30)	64 (31)	73 (35)	81 (42)
1956	89 (48)	98 (53)	109 (60)	119 (68)	127 (77)	137 (89)	146 (95)	150 (105)	151 (119)	156 (135)	160 (147)	164 (150)
1957	170 (150)	172 (150)	174 (150)	181 (150)	186 (150)	188 (150)	191 (150)	194 (150)	197 (150)	200 (150)	201 (150)	200 (150)
1958	199 (150)	201 (150)	201 (150)	197 (150)	191 (150)	187 (150)	185 (150)	185 (150)	184 (150)	182 (150)	181 (150)	180 (150)
1959	179 (150)	177 (150)	174 (150)	169 (150)	165 (146)	161 (143)	156 (141)	151 (142)	146 (141)	141 (139)	137 (137)	132 (137)
1960	129 (136)	125 (135)	122 (133)	120 (130)	117 (125)	114 (120)	109 (118)	102 (115)	98 (110)	93 (108)	88 (105)	84 (100)
1961	80 (100)	75 (90)	69 (90)	64 (90)	60 (85)	56 (85)	53 (80)	52 (75)	52 (70)	51 (70)	50 (65)	49 (60)
1962	45 (60)	42 (50)	40 (48)	39 (45)	39 (42)	38 (37)	36 (34)	34 (31)	32 (29)	31 (28)	30 (27)	30 (34)
1963	29 (31)	30 (28)	30 (26)	(25)	(25)	(25)	(23)	(21)	(20)	(18)	(18)	(17)
1964	(17)	(17)	(17)*									

Note: Final numbers are listed through June 1962, the succeeding values being based on provisional data. The predicted numbers are in parentheses.

* Number used for predictions in this issue.

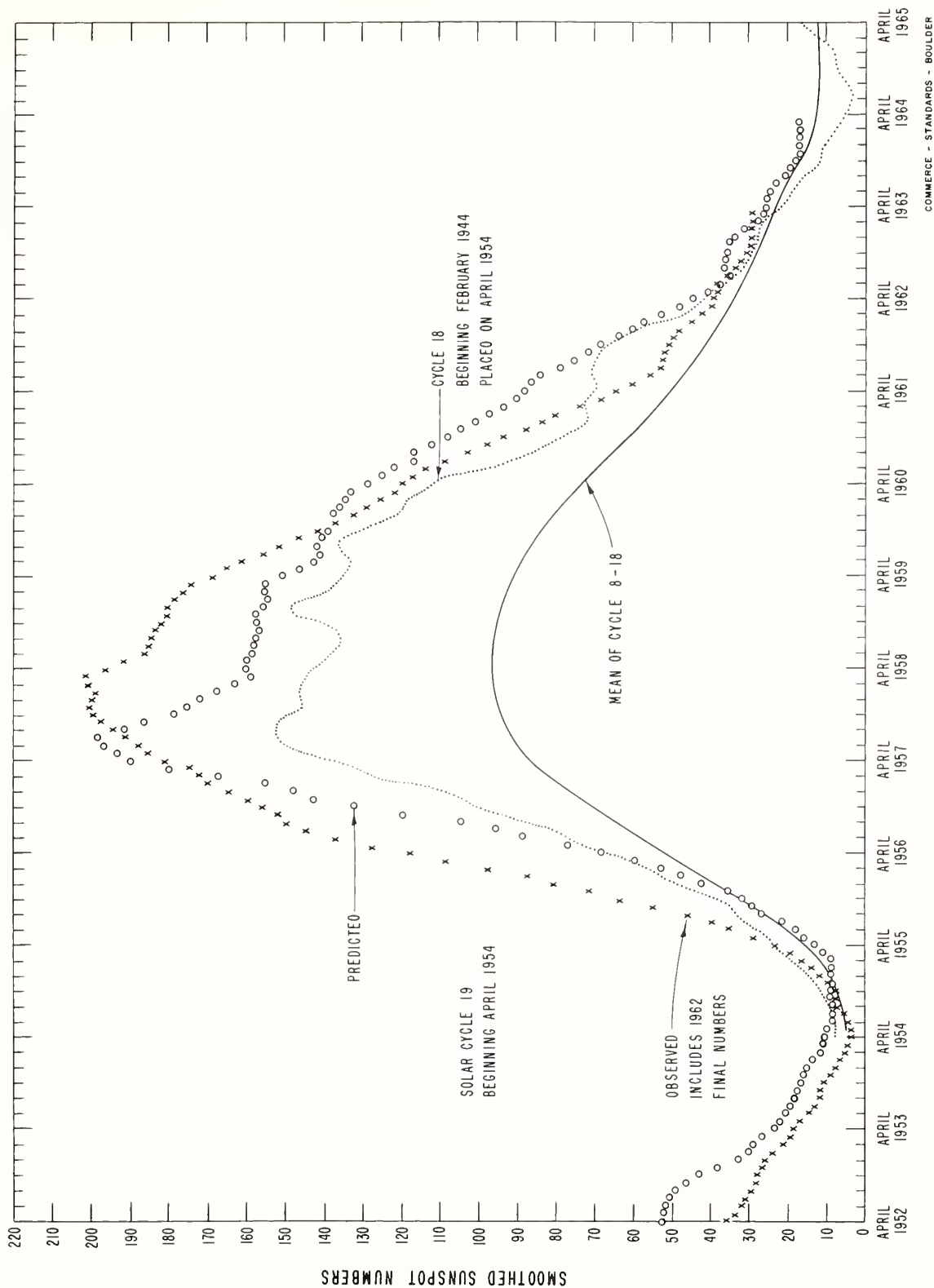


FIG. A. PREDICTED AND OBSERVED SUNSPOT NUMBERS

TABLE 1

TIME VARIATION

[illegible]

Harmonic		5				6				7				8			
		9	10	11	12	13	14	15	16								
I	K																
	0	1.3983159E-01	1.8827802E-01	-1.0702080E-01	6.451485E-02	-7.8780842E-02	-7.4630190E-02	6.3280606E-02	-3.9924226E-02								
	1	2.7009793E-02	1.0894337E-03	4.5662184E-04	1.6469580E-03	-1.2649175E-02	-2.5099145E-03	-5.7178290E-03	2.3532820E-04								
	2	-1.4903492E-01	1.1184531E-01	8.5458648E-02	-1.4625086E-01	1.2625086E-01	7.9362801E-02	-6.7504349E-02	4.1931646E-02								
	3	-6.8963363E-03	-8.0081377E-03	-8.8564138E-03	8.0081377E-03	8.5300808E-03	-8.5300808E-03	-6.0653766E-02									
	4				8.5907735E-03												

(- Main latitudinal variation, Mixed latitudinal and longitudinal variation: II - First order in longitude, III - Second order in longitude

otation: For each entry the number given by the first eight digits and sign is multiplied by the power of ten defined by the last two digits and sign.

PREDICTED COEFFICIENTS D_{sk} DEFINING THE FUNCTION $\Gamma(\lambda, \theta, \dagger)$ FOR MONTHLY MEDIAN f_0 F2 (Mc/s)

MARCH 1964

TABLE 2

TIME VARIATION

Harmonic	O	I	2	3	4	5	6
K	S	I	2	3	4	5	6
I	0	-1.2132436E-01	-3.2045389E-01	3.5323513E-02	-1.1720262E-01	2.2047714E-02	-5.1177274E-02
1	0	-2.5078654E-02	-1.0381138E-01	1.2581126E-01	-4.4272063E-02	-5.2138180E-02	2.2027646E-02
2	0	5.7545920E-01	3.5991365E 00	-1.0177804E-01	1.2515027E-01	-6.3838907E-01	-8.7685655E-02
3	0	2.8695307E-01	9.7877933E-01	-6.9731904E-01	-1.5535699E-01	1.6389049E-01	-1.3780680E-01
4	0	-6.3574459E-01	-1.0025512E 00	-1.8719482E-01	4.9893697E-01	2.4711342E 00	2.1650835E-01
5	0	-4.8404545E-01	-1.9023512E 00	1.1239921E 00	-6.6231724E-01	-1.5851479E-01	2.3504292E-01
6	0	-1.2542736E 00	1.1908853E 01	4.7240819E-01	-3.8133855E-01	4.2404772E 00	-8.4489464E-01
7	0	1.0081183E-01	1.1908853E 01	5.2957915E-01	5.3218713E-02	3.0980403E-02	-1.2890929E-01
8	0	2.3925664E-01	1.0424197E 00	-2.5196002E-01	9.6486022E-02	1.4219406E 00	4.4204245E-01
9	0	1.3891667E-01	-5.1409542E 00				
II	0	-2.6048046E-02	5.4670651E-02	-6.7163382E-03	1.1844807E-02	1.2616429E-02	4.6220624E-03
10	0	-2.0028450E-02	-2.5576538E-03	-5.1883887E-03	-3.4961541E-03	2.1276597E-02	3.5978719E-03
11	0	-1.2599474E-01	2.9141105E-01	4.0071412E-02	7.9409260E-02	-2.2047018E-02	-4.0160131E-02
12	0	-3.2687226E-01	-5.968592E-01	8.8080843E-02	6.5719095E-02	1.4918808E-01	5.7226365E-02
13	0	8.4401743E-02	-5.6628979E-01	4.1277782E-02	-6.4381071E-02	-1.9381848E-01	1.1809139E-01
14	0	-2.5929827E-02	7.4405389E-02	3.1987832E-01	-3.4761956E-02	-2.9197902E-01	3.8022282E-02
15	0	6.7243896E-01	-7.3513902E-01	-4.1444750E-01	-3.8766477E-01	6.6546330E-01	2.5587201E-01
16	0	2.0760771E 00	3.9380098E 00	-5.0515394E-01	-7.6437334E-01	-1.0477451E 00	-3.6446418E-01
17	0	5.1719401E-01	2.0785795E 00	-3.9047333E-01	-3.9841161E-01	9.2442366E-01	-9.8739365E-01
18	0	1.2981760E 00	3.5256109E-01	-1.9674754E 00	6.8521699E-01	1.2123277E 00	-4.1410522E-01
19	0	-3.9408296E 00	-6.4985278E 00	7.7107803E-01	8.5494953E-01	-1.5749564E 00	-4.5659906E-01
20	0	-2.0055809E 00	-3.3141992E 00	1.0111722E 00	1.78264087E 00	1.9772308E 00	6.2672676E-01
21	0	-3.1076427E-01	-2.1403039E-01	8.5924009E-01	1.2926112E 00	-1.5396265E 00	2.1886809E 00
22	0	1.2019030E-01	-3.1076427E-01	3.8667181E 00	-1.6590065E 00	-1.8247800E 00	9.9200926E-01
23	0	5.9198374E-01	-2.1403039E-01	-4.2109645E-01	-6.1281384E-01	1.0647072E 00	2.5786823E-01
24	0	2.4043539E 00	3.8398979E 00	-6.4611882E-01	-1.1260651E 00	-1.1078838E 00	-2.9535613E-01
25	0	1.6238443E 00	1.7755733E 00	-5.5817816E-01	-8.3865110E-01	8.1730891E-01	-1.4132124E 00
26	0	2.0080514E 00	1.2580244E 00	-2.3066643E 00	1.0930397E 00	8.9889554E-01	-6.1682368E-01
III	0	-1.5444629E-02	1.4939097E-02	-1.1990718E-02	-1.46611973E-02	-1.9087017E-03	-1.8816444E-03
27	0	-1.7000662E-02	-2.0011426E-02	-2.4425370E-03	1.6730140E-02	6.3157740E-03	2.0922439E-03
28	0	-1.3348170E-01	8.0865753E-02	2.8528650E-02	-1.1155434E-02	4.5672680E-02	-2.4073011E-03
29	0	2.1973512E-02	-6.5777060E-02	1.3507222E-02	1.3207889E-02	5.1134909E-02	5.0162316E-02
30	0	3.1607744E-02	-1.3989155E-02	8.1395063E-02	1.8075699E-01	3.0503215E-02	9.9237871E-03
31	0	1.6110054E-02	8.5718403E-02	-1.5024392E-01	-2.67913165E-02	-6.9983408E-03	-4.8496964E-03
32	0	3.2940412E-01	2.5632252E-02	-1.2671098E-04	-2.9136165E-02	-6.5966961E-02	9.4886063E-03
33	0	1.6156332E-02	-2.6083595E-03	-1.1109710E-01	-2.7617481E-01	-1.1618464E-01	-1.2751433E-01
34	0			2.7049589E-01			
35	0						
36	0						

GEOGRAPHICAL VARIATION

GEOGRAPHICAL VARIATION

Harmonic	4		5		6		
	7	8	9	10	11	12	
K	S						
I	0	4.0867141E-02	3.1201055E-03	1.3370479E-02	4.0834509E-02	-2.2099212E-02	7.4394204E-03
	1	2.8856898E-03	-3.1450844E-03	5.1257822E-03	4.1761307E-03	4.9569381E-04	1.8050644E-03
	2	-3.4969386E-02	1.6835189E-03	-1.5535652E-02	-3.7536399E-02	2.0684282E-02	-1.0692582E-02
	3						

I - Main latitudinal variation. Mixed latitudinal and longitudinal variation; II - First order in longitude, III - Second order in longitude.
 Notation: For each entry the number given by the first eight digits and sign is multiplied by the power of ten defined by the last two digits and sign.

PREDICTED COEFFICIENTS D_{SK} DEFINING THE FUNCTION $\Gamma(\lambda, \theta, t)$ FOR MONTHLY MEDIAN $M(3000)F2$

MARCH 1964

MARCH 1964 UT=00

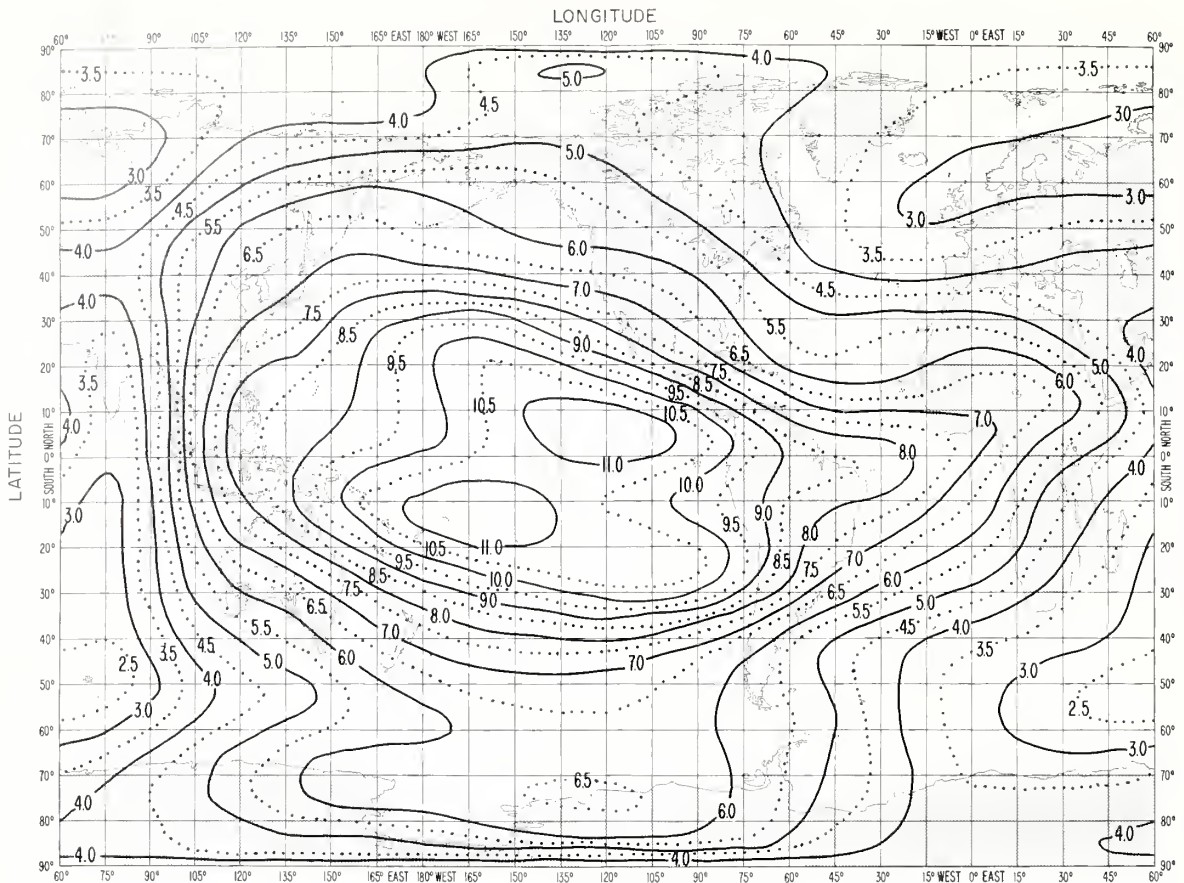


FIG. 1A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

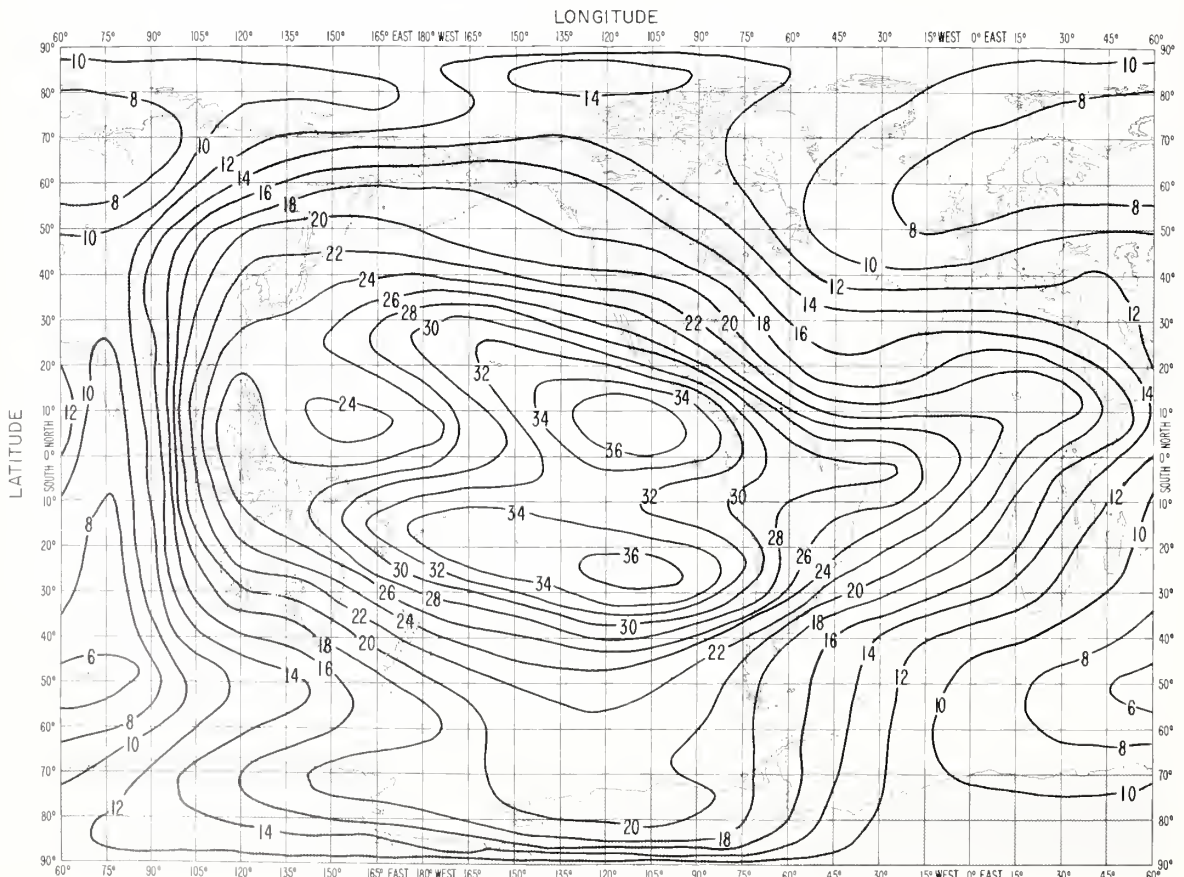


FIG. 1B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

MARCH 1964 UT=02

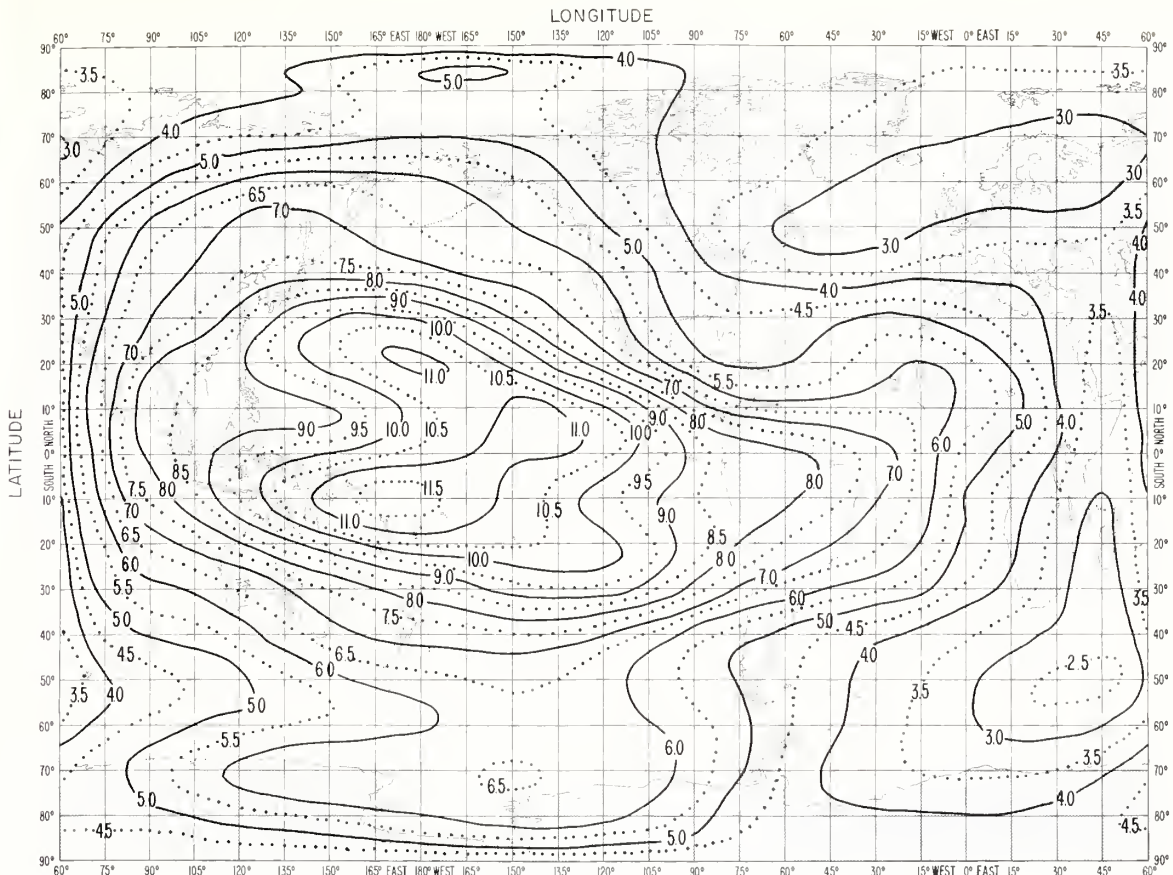


FIG. 2A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

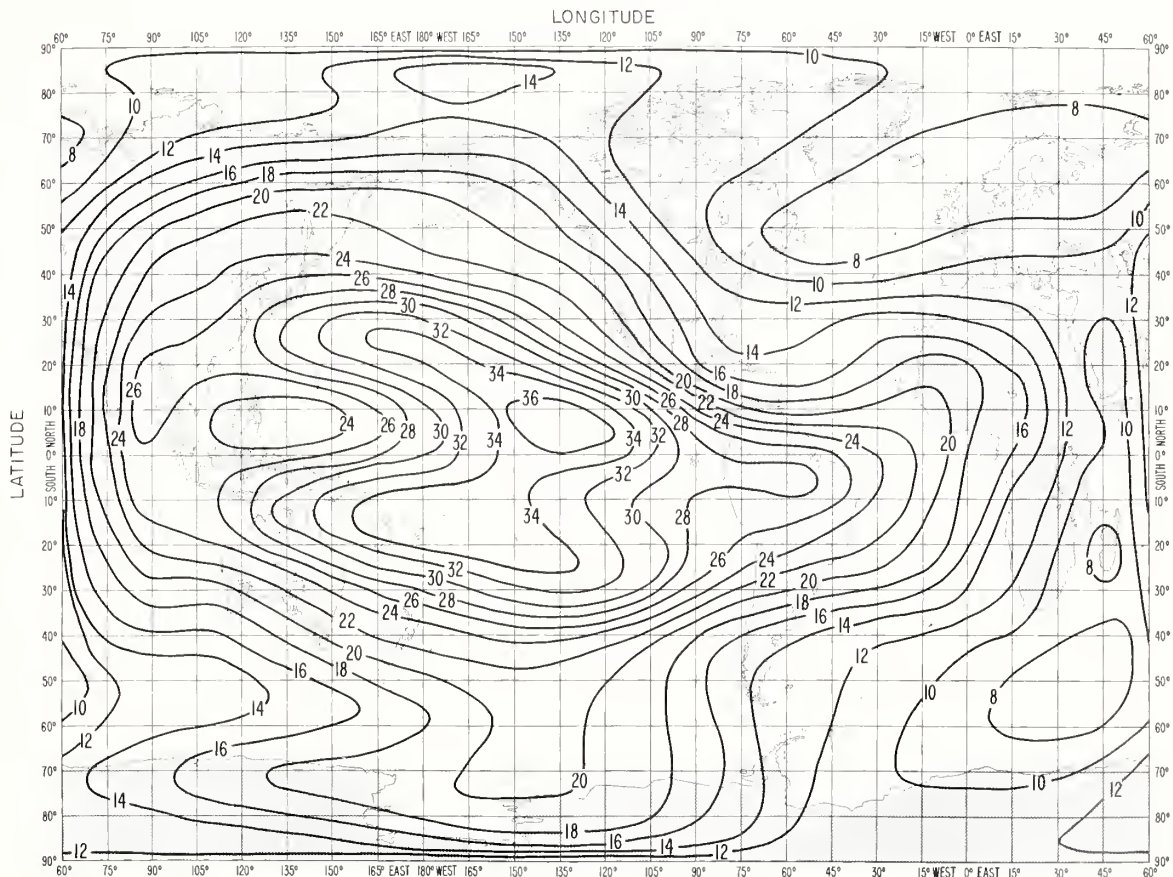


FIG. 2B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

MARCH 1964 UT=04

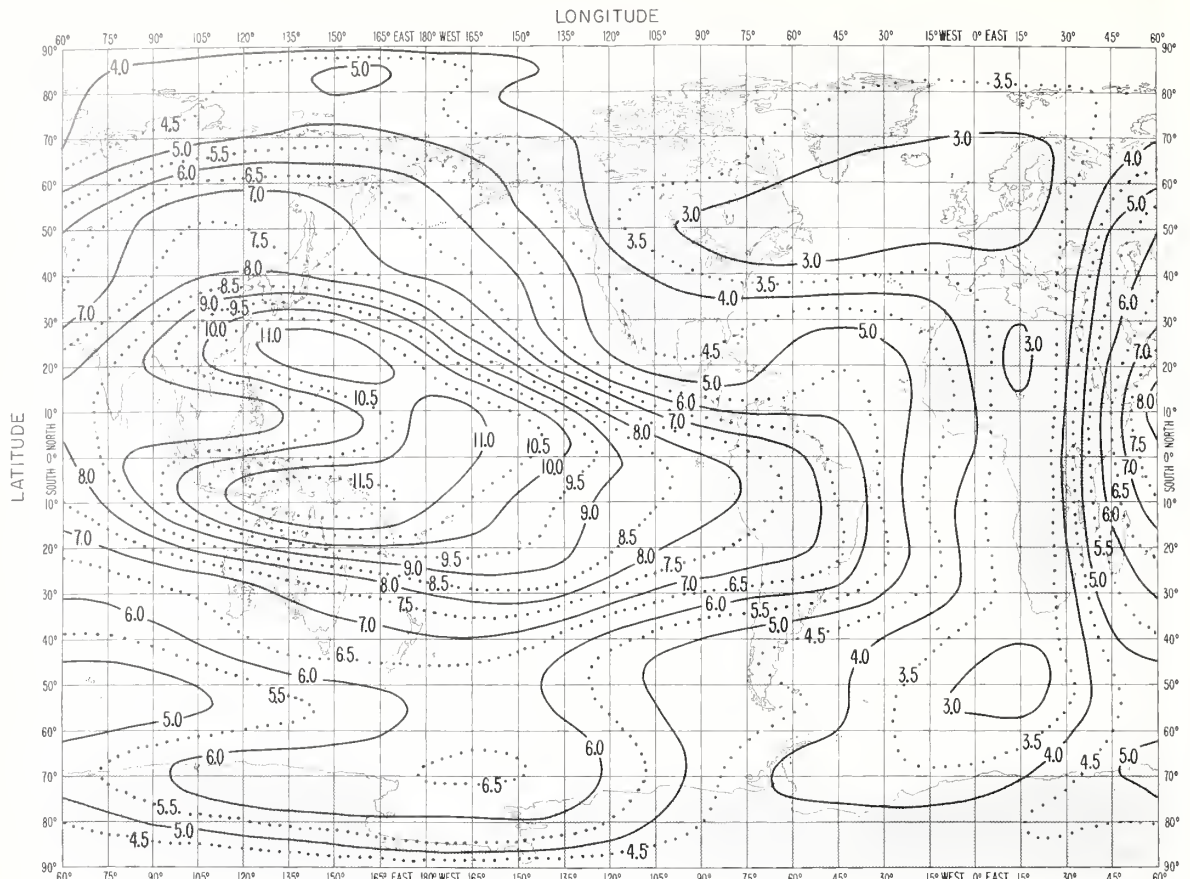


FIG. 3A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

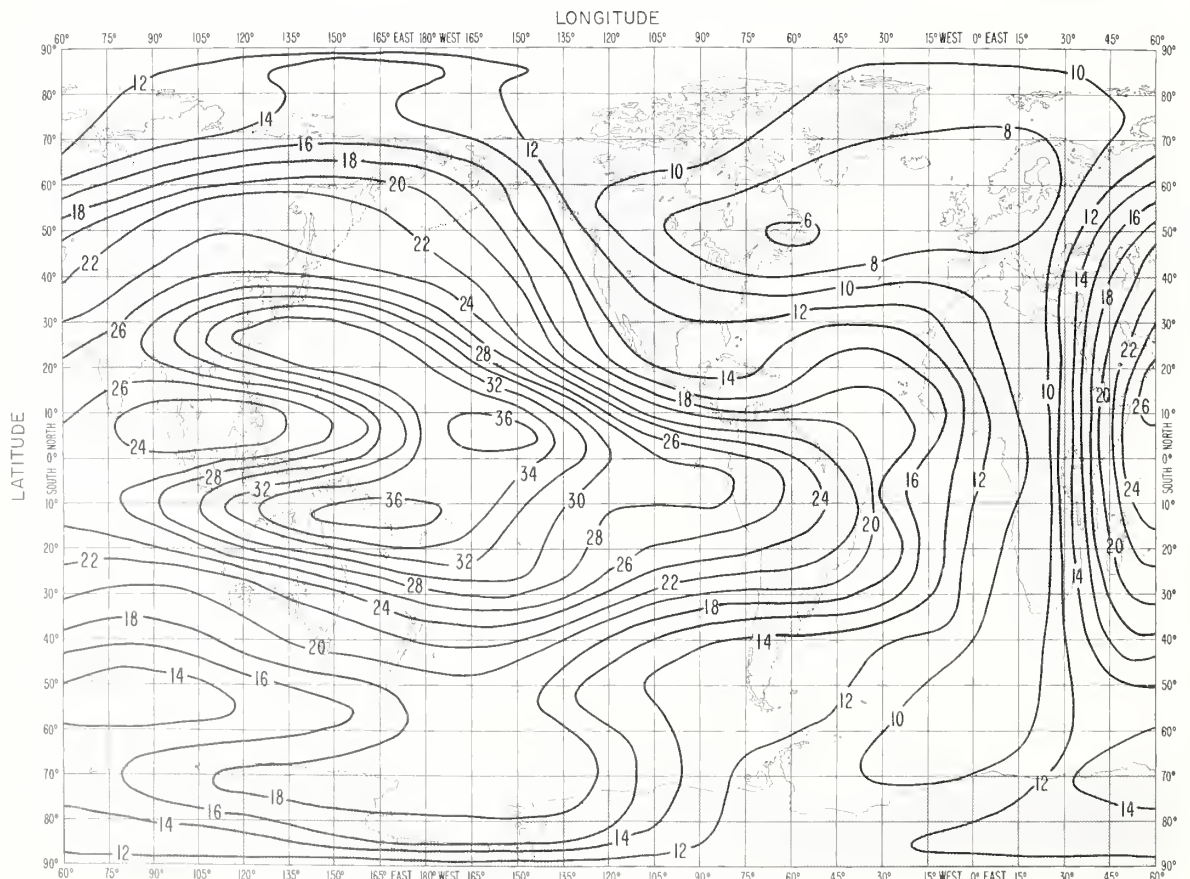
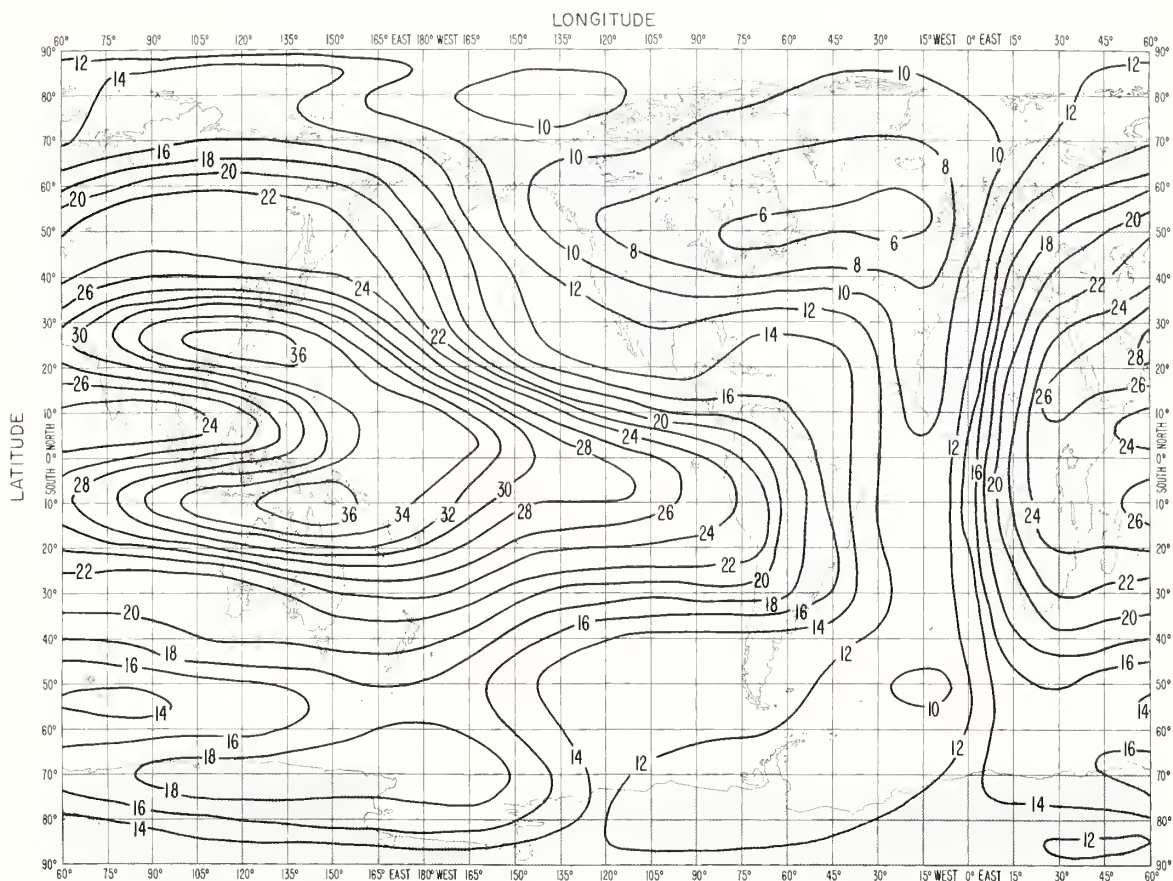
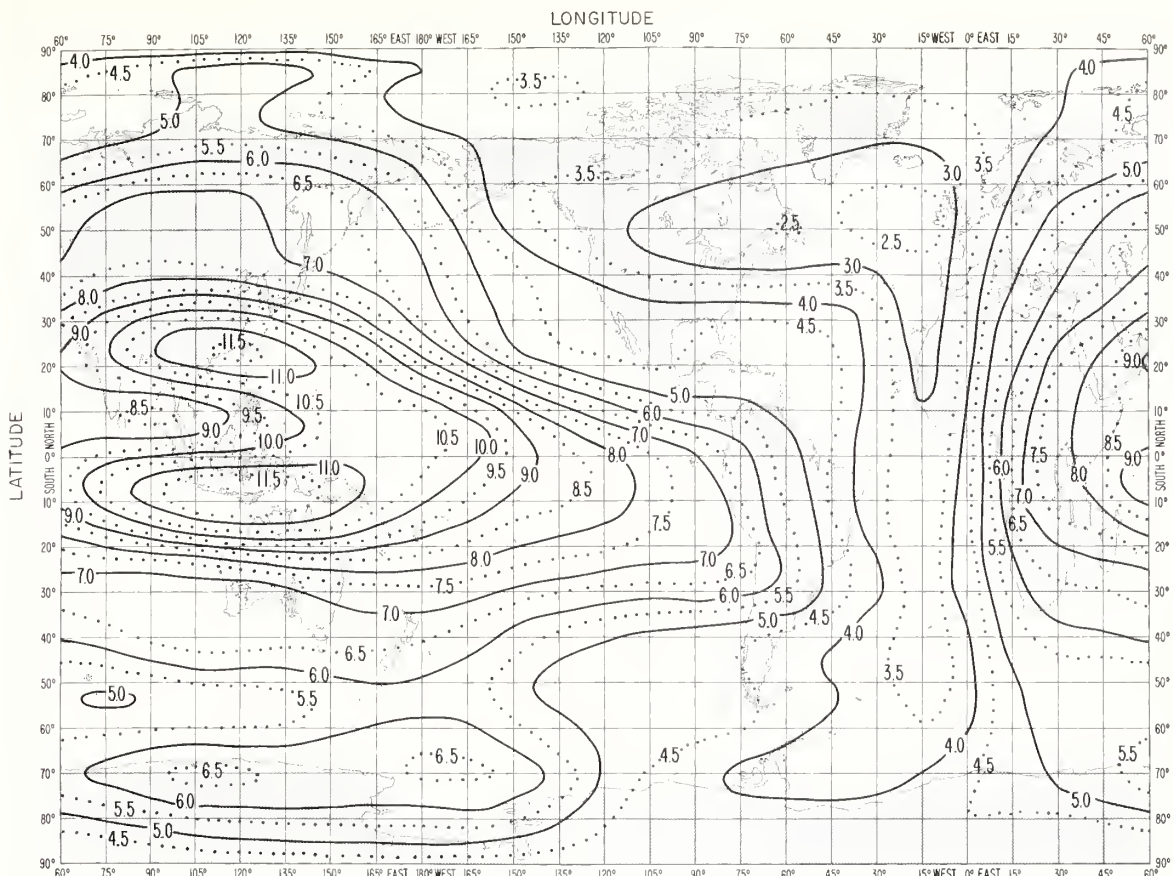
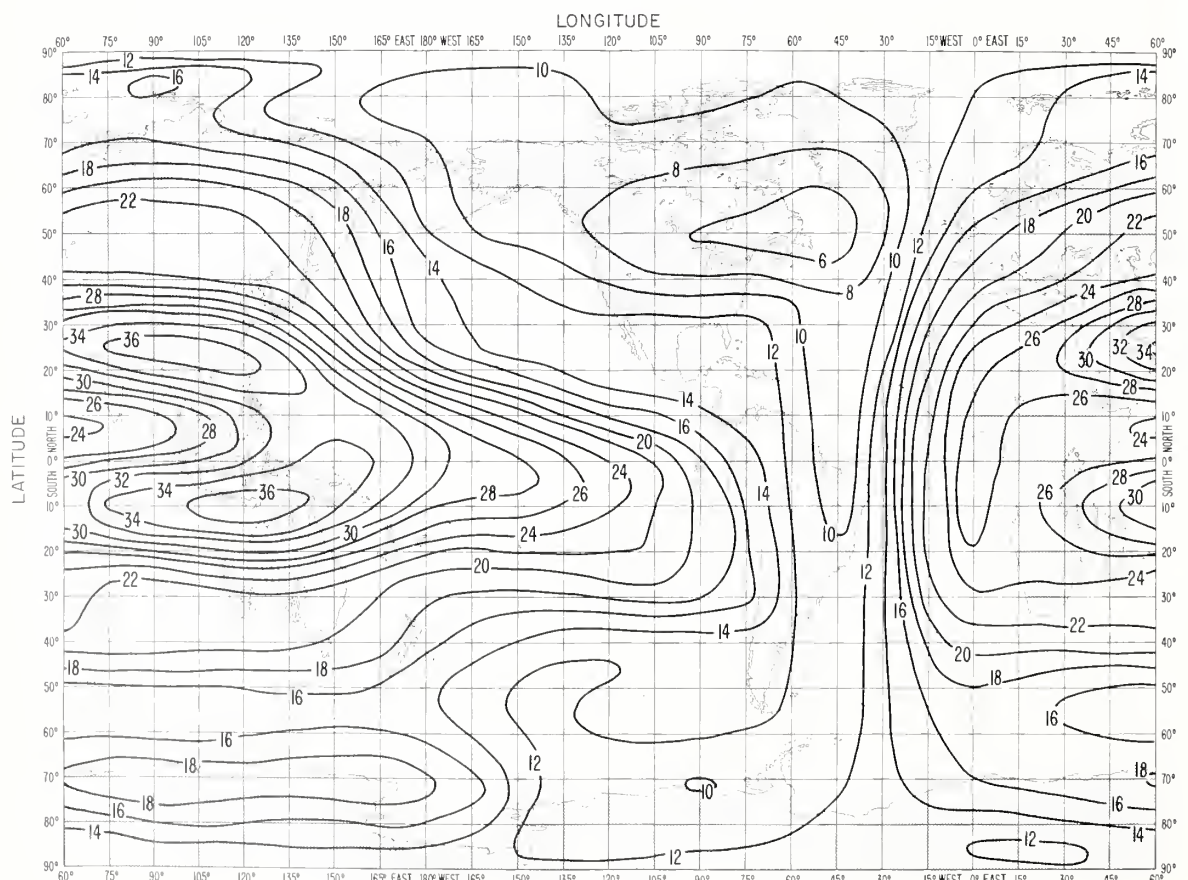
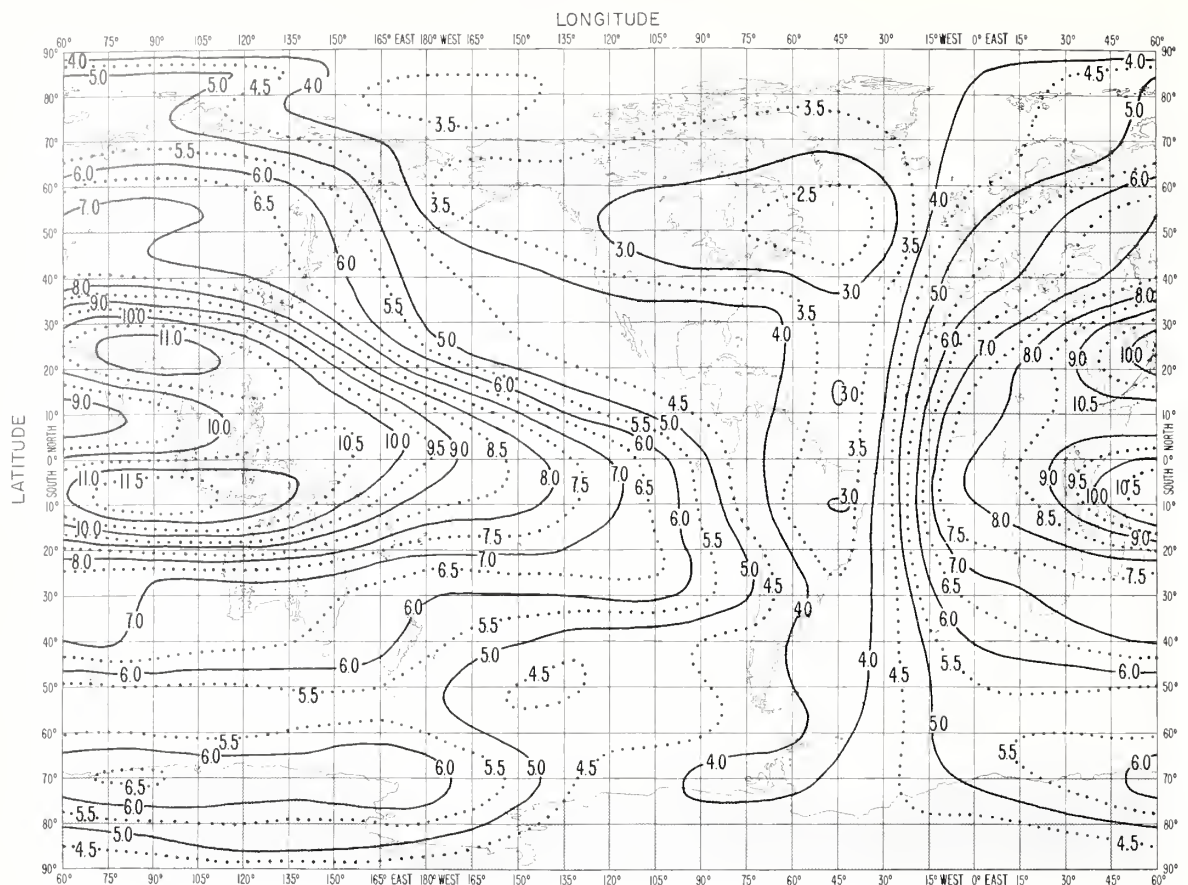


FIG. 3B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

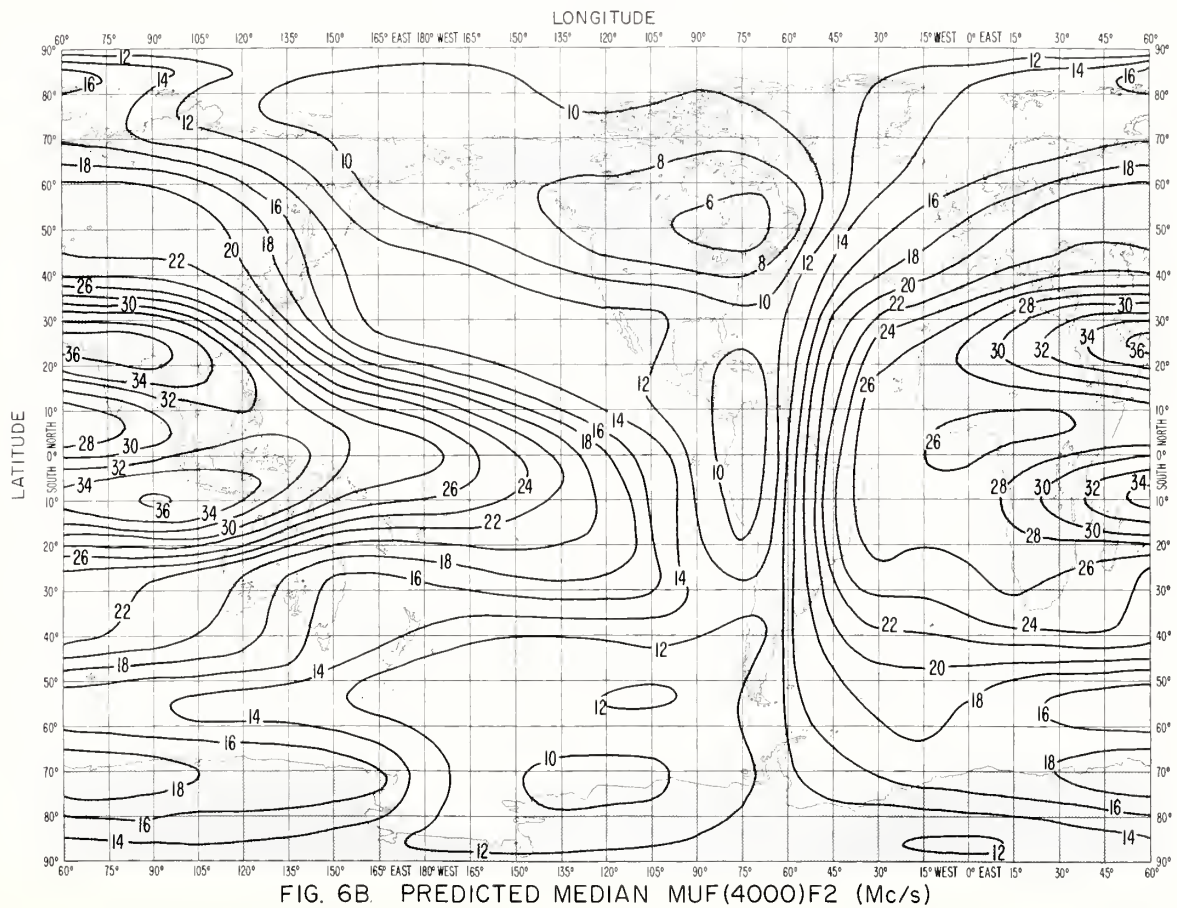
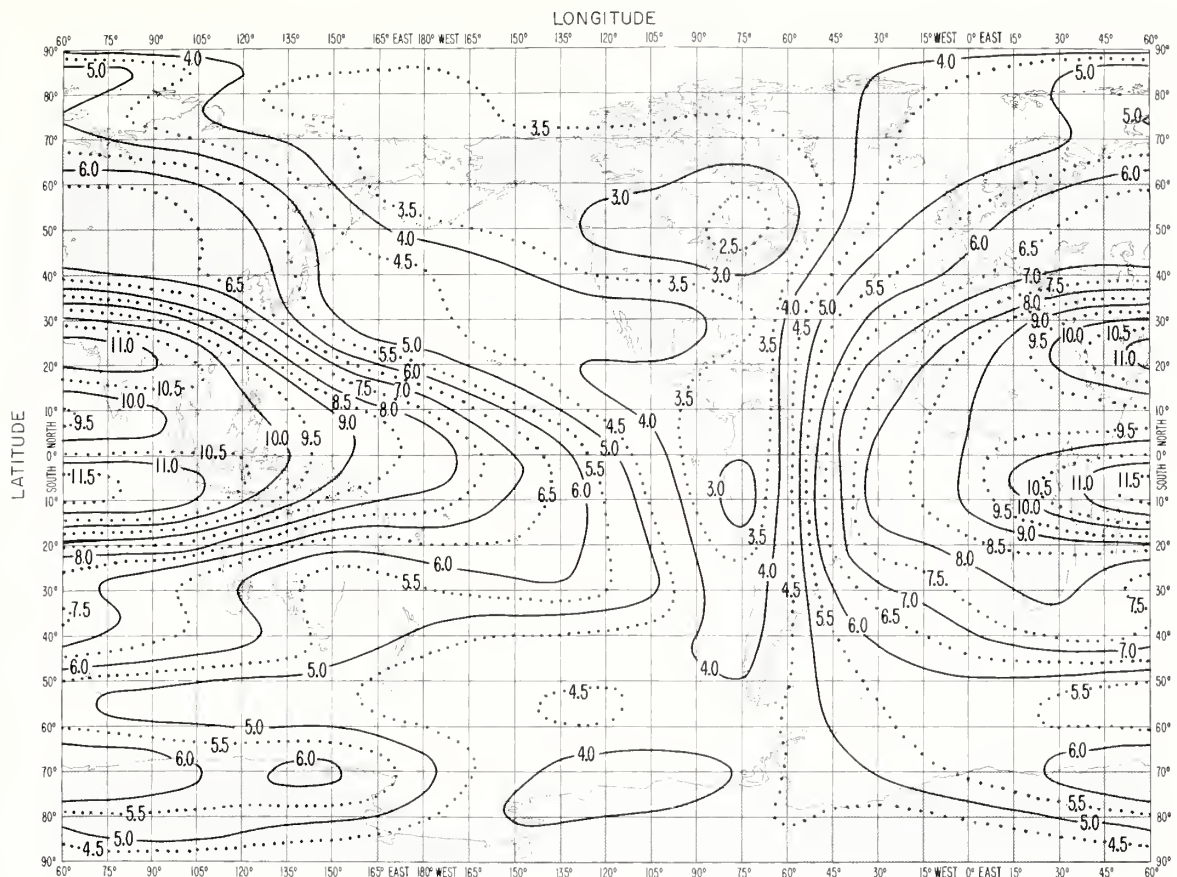
MARCH 1964 UT=06



MARCH 1964 UT=08



MARCH 1964 UT=10



MARCH 1964 UT=12

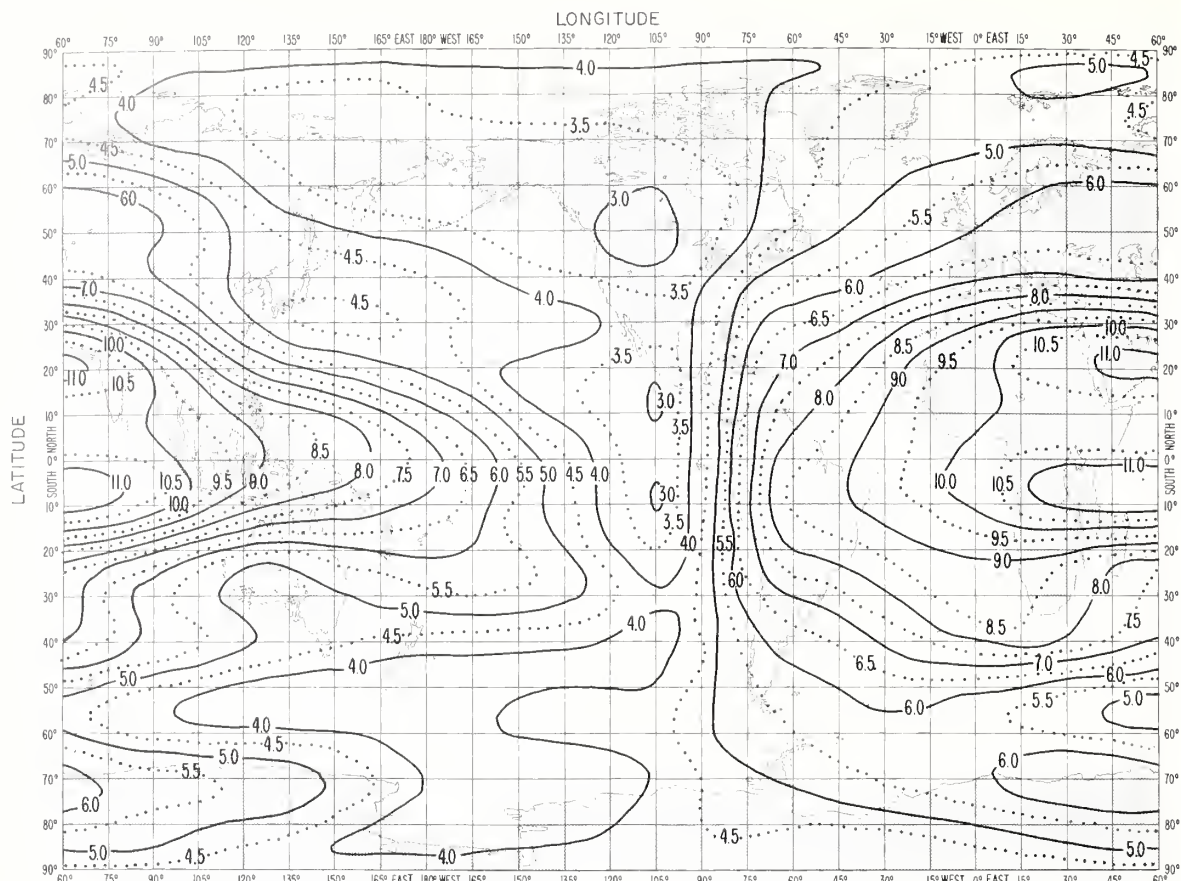


FIG. 7A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

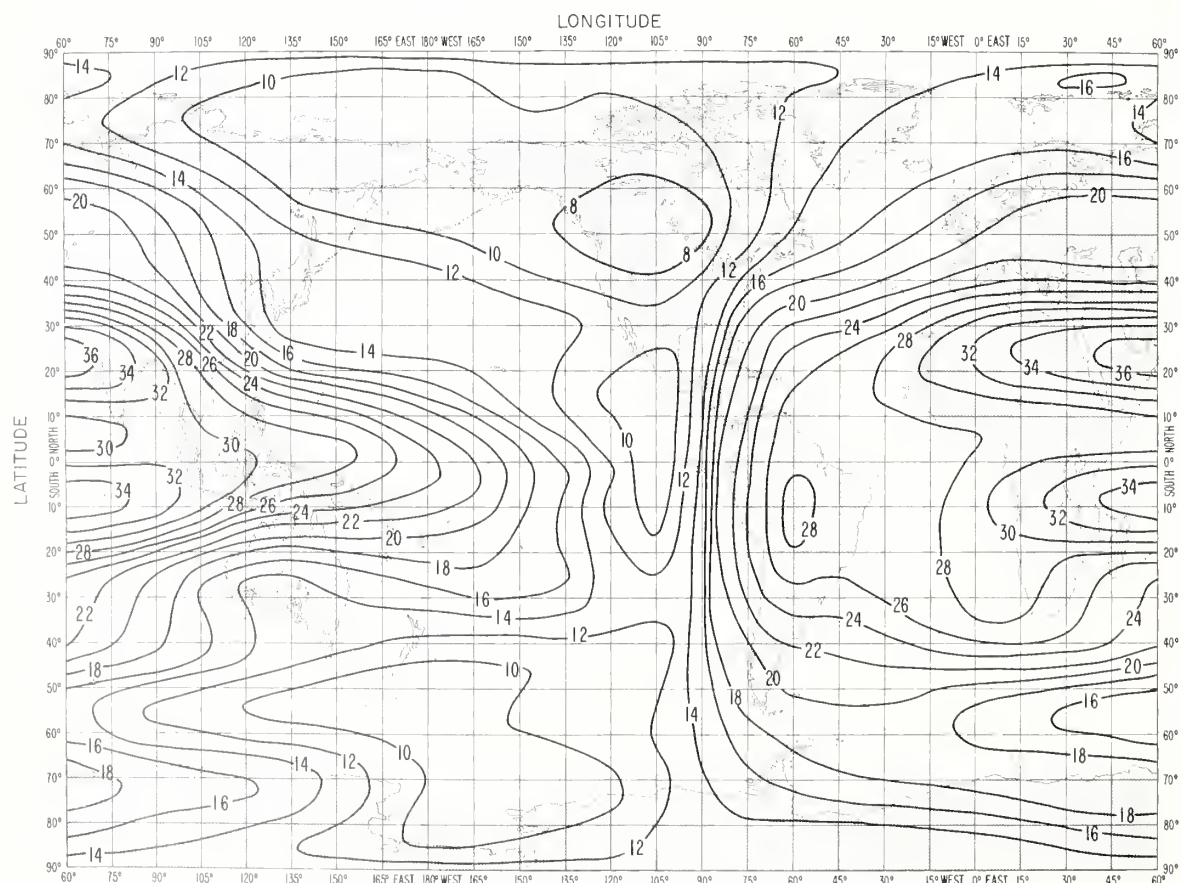


FIG. 7B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

MARCH 1964 UT=14

LONGITUDE

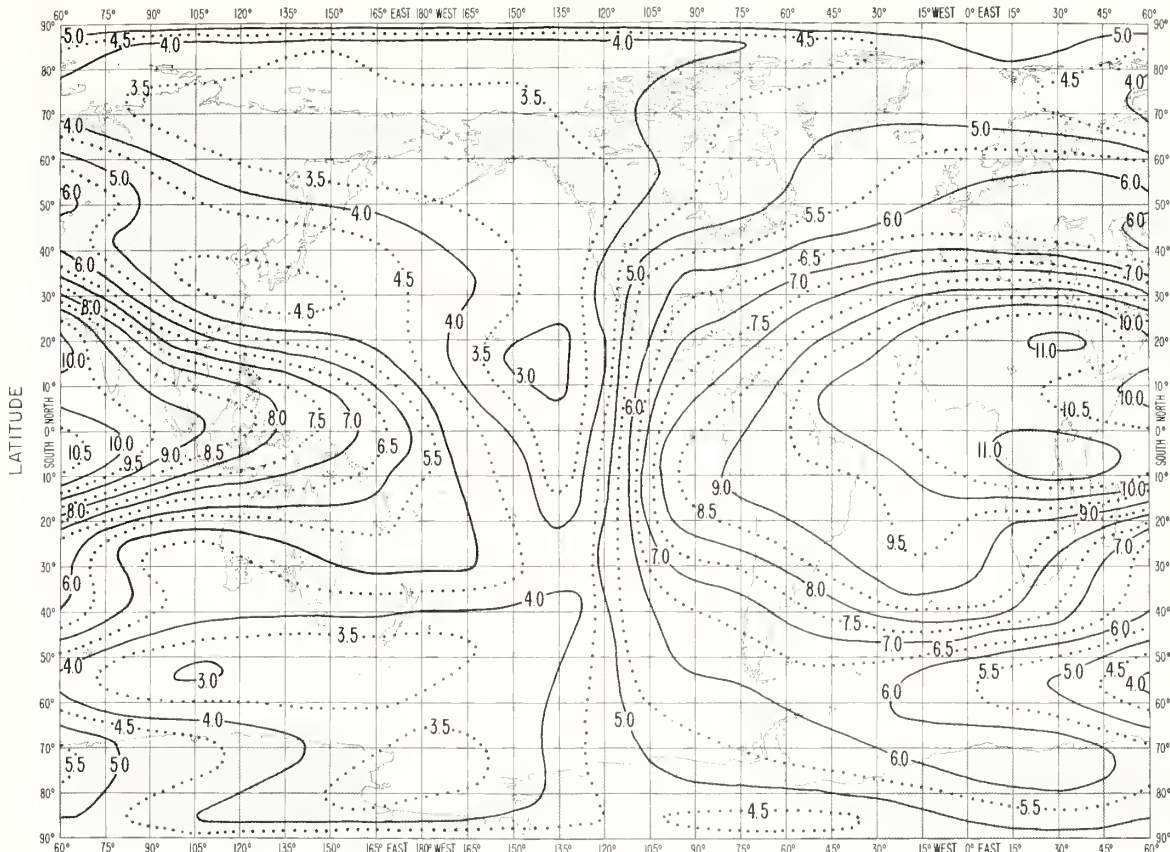


FIG. 8A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

LONGITUDE

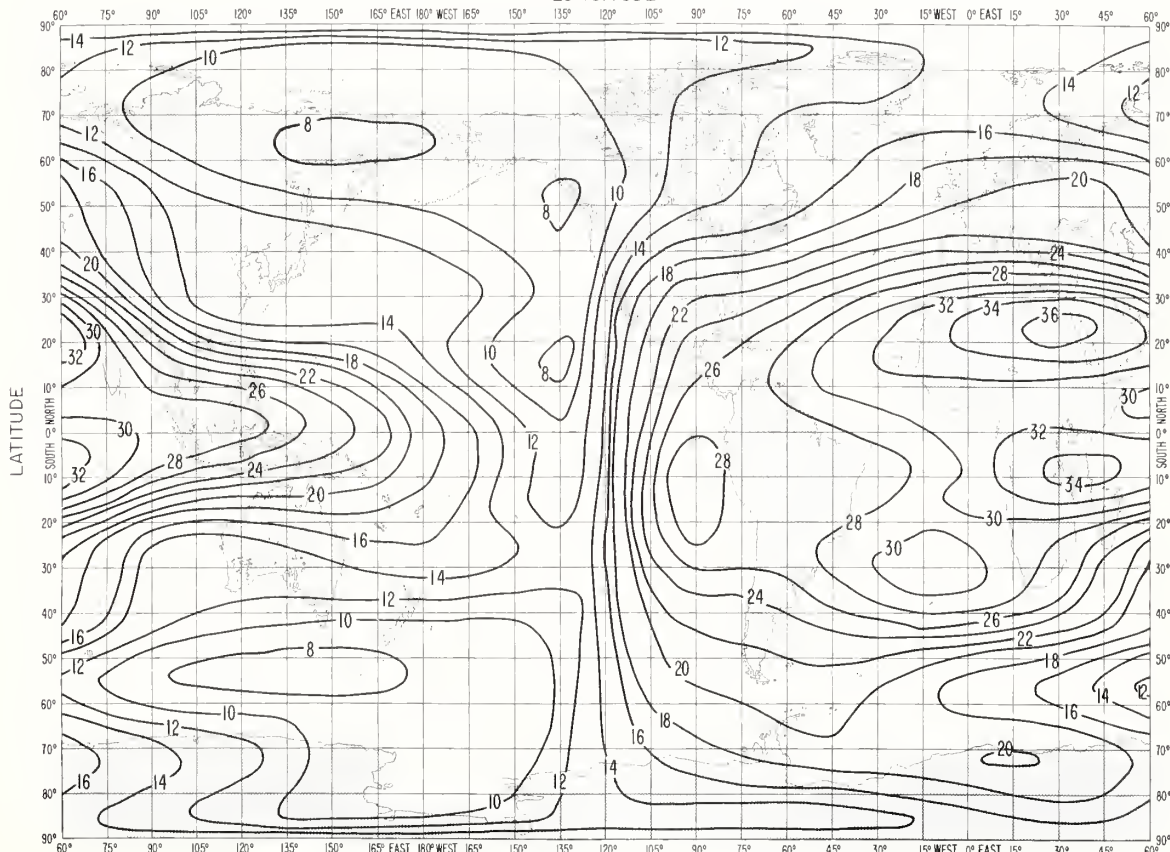


FIG. 8B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

MARCH 1964 UT=16

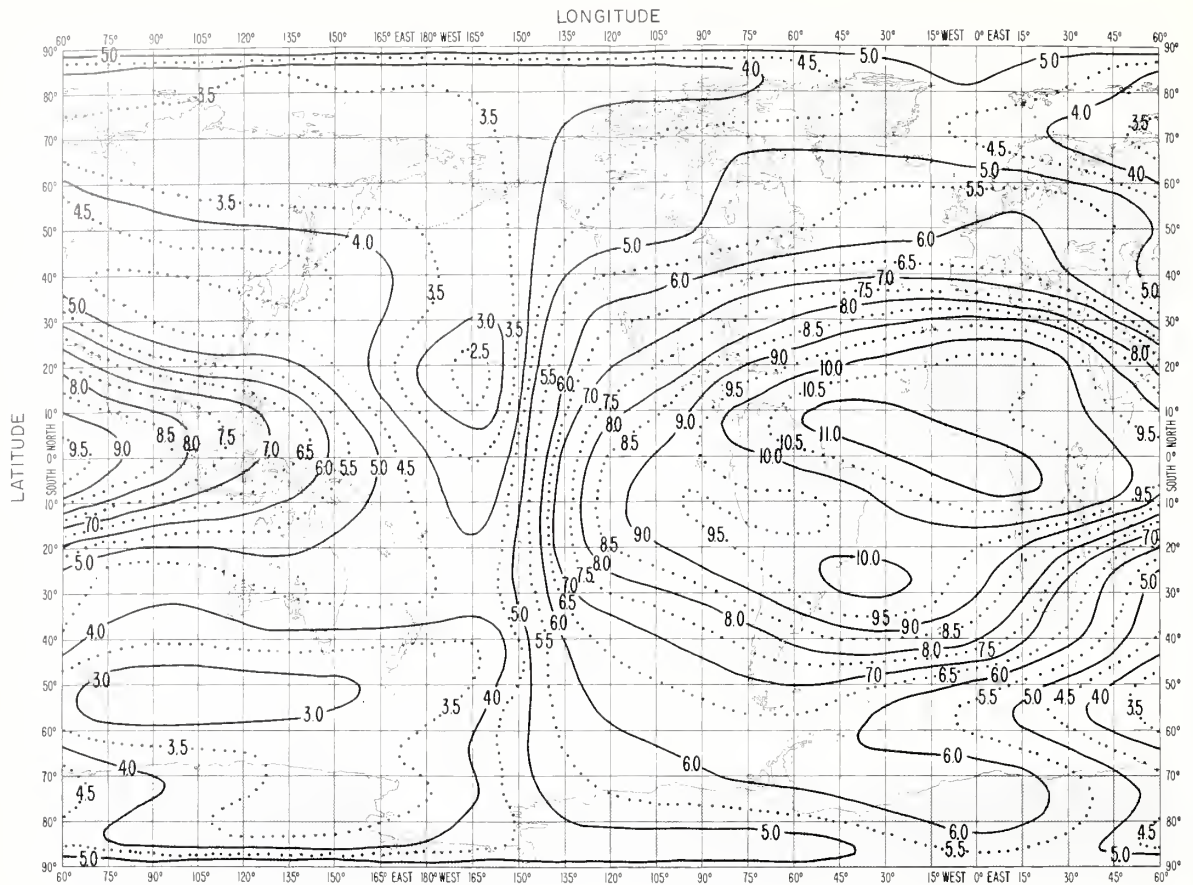


FIG. 9A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

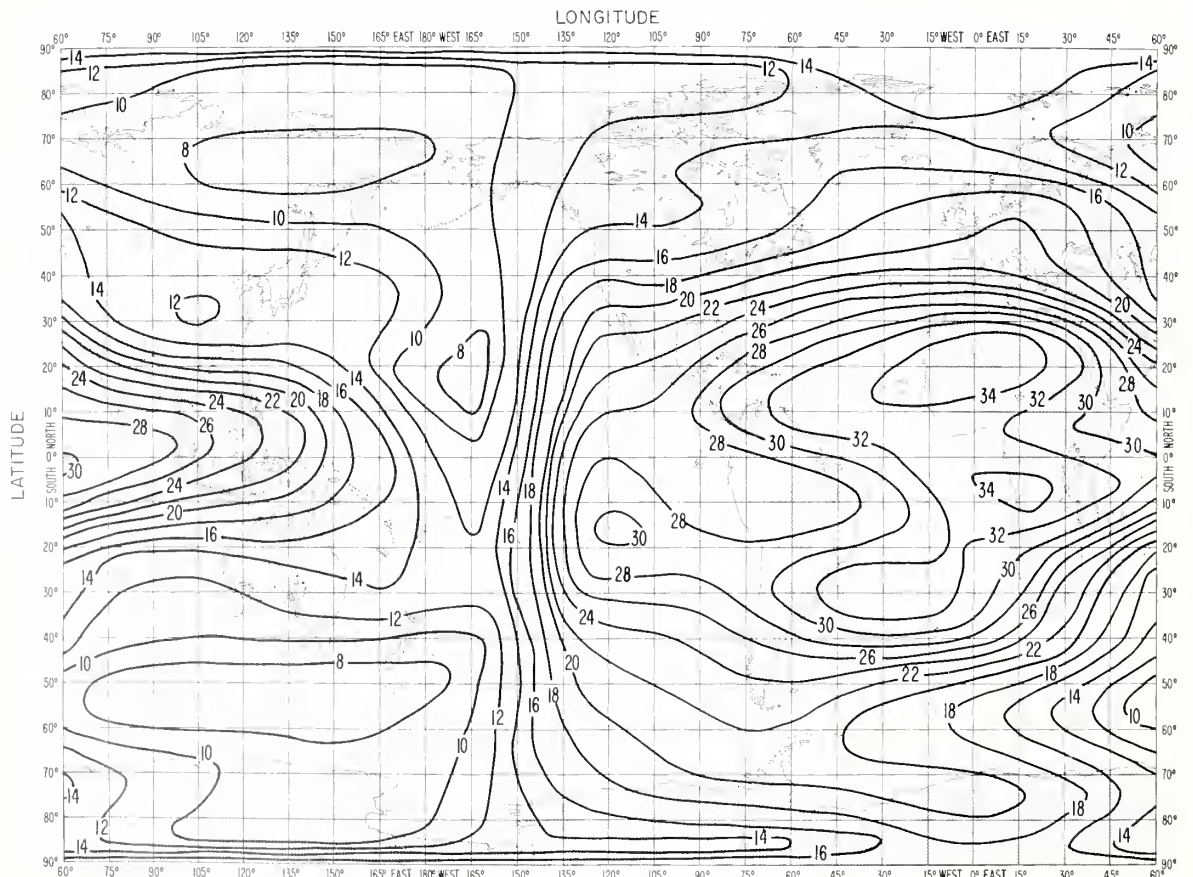


FIG. 9B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

MARCH 1964 UT=18

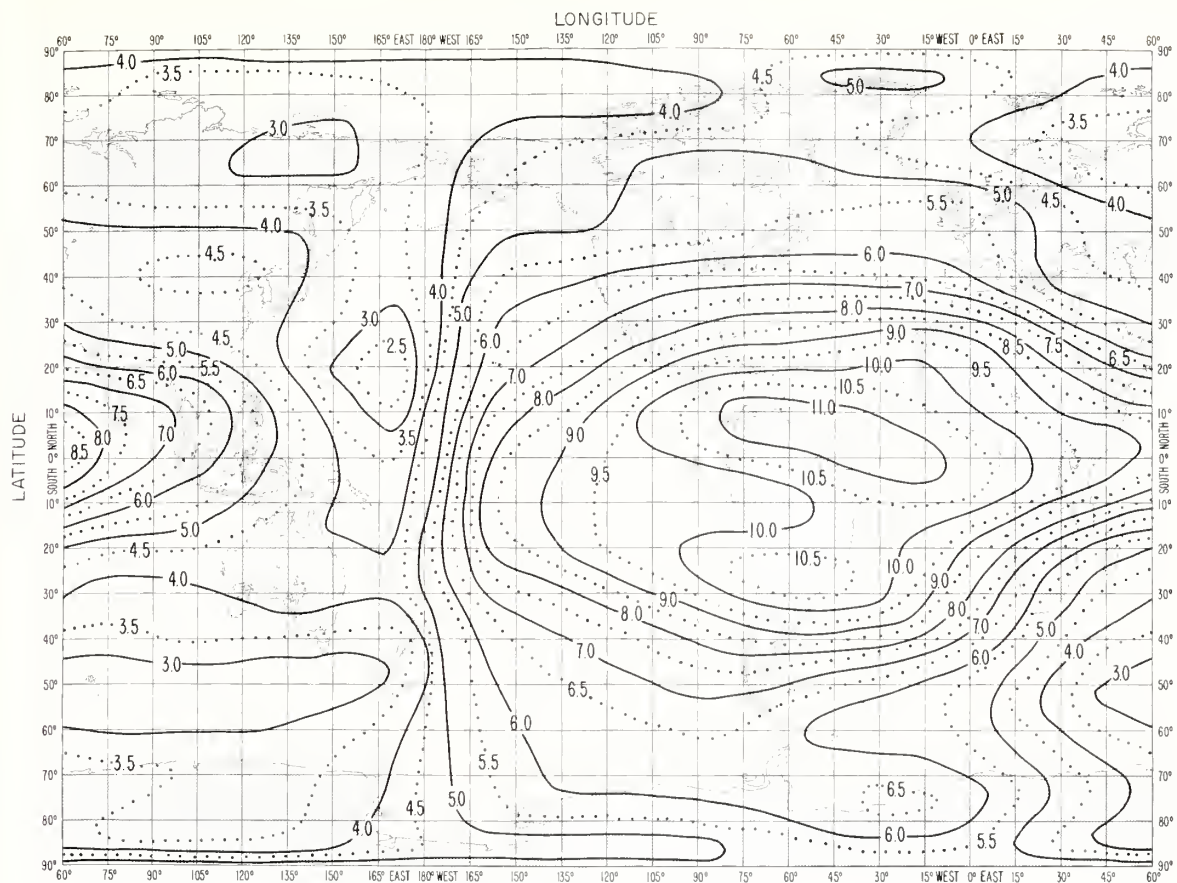


FIG.10A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

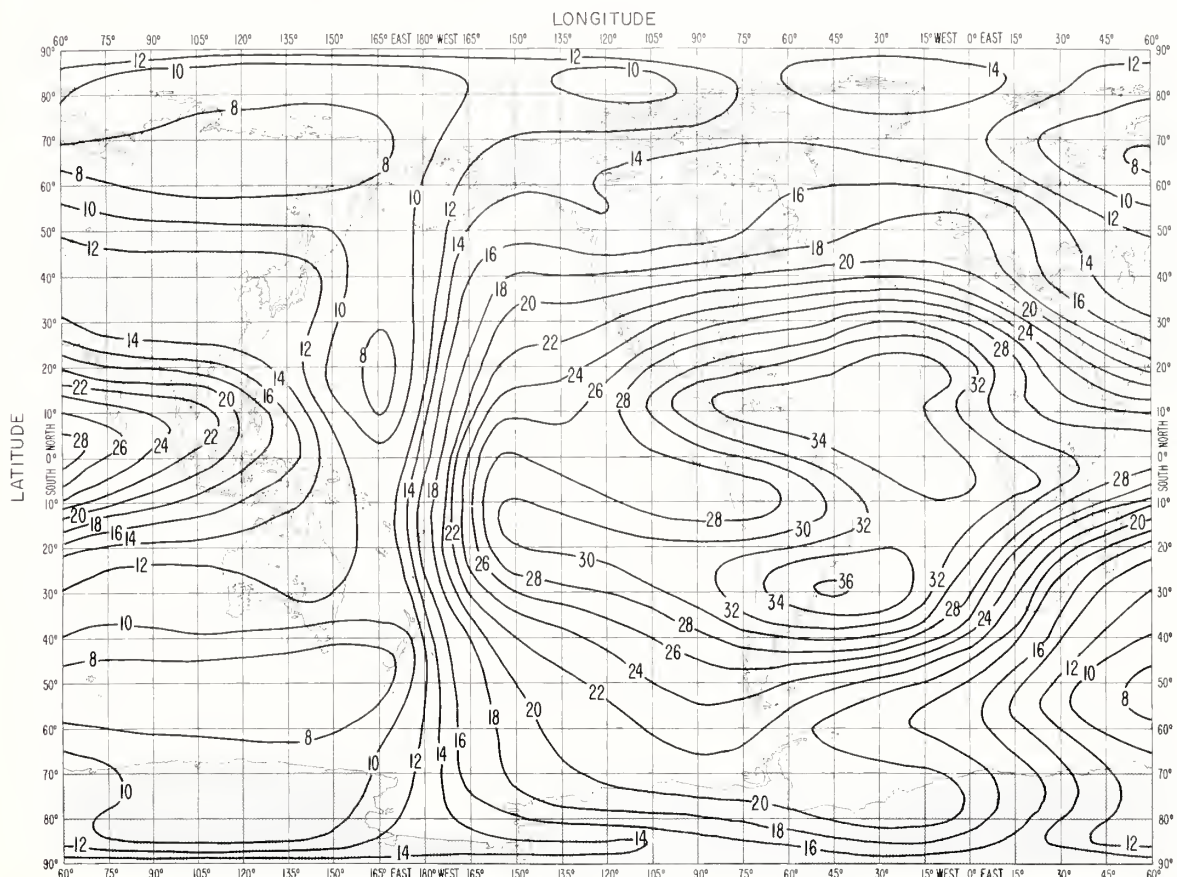


FIG. 10B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

MARCH 1964 UT=20

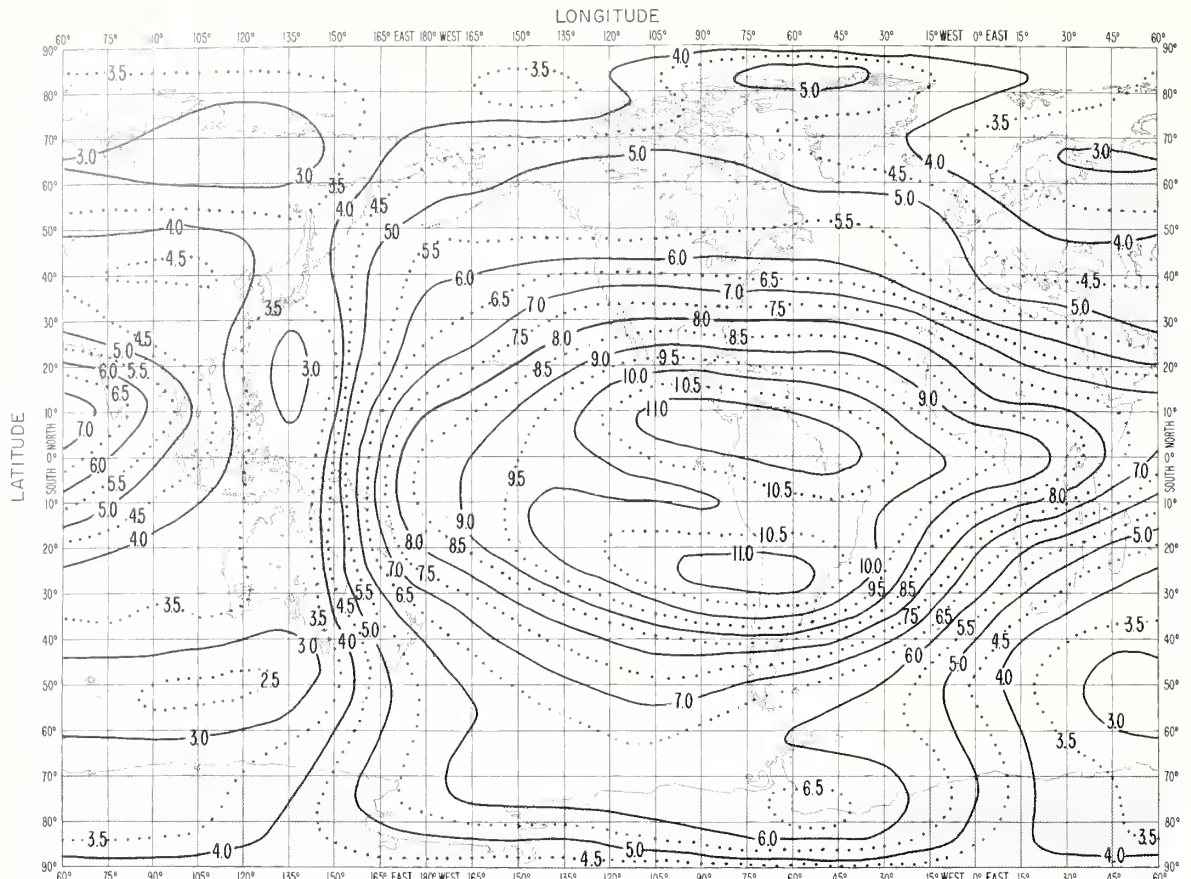


FIG. IIA. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

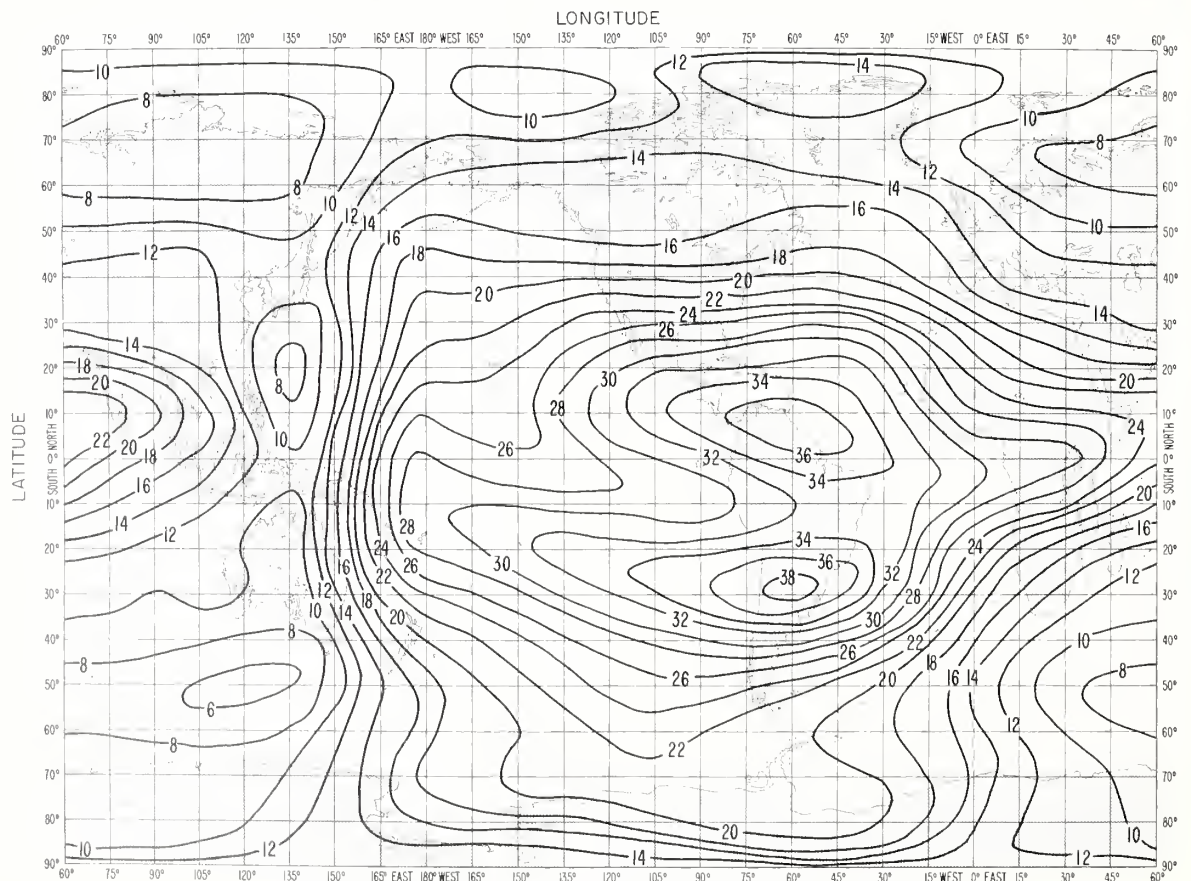


FIG. IIB. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

MARCH 1964 UT=22

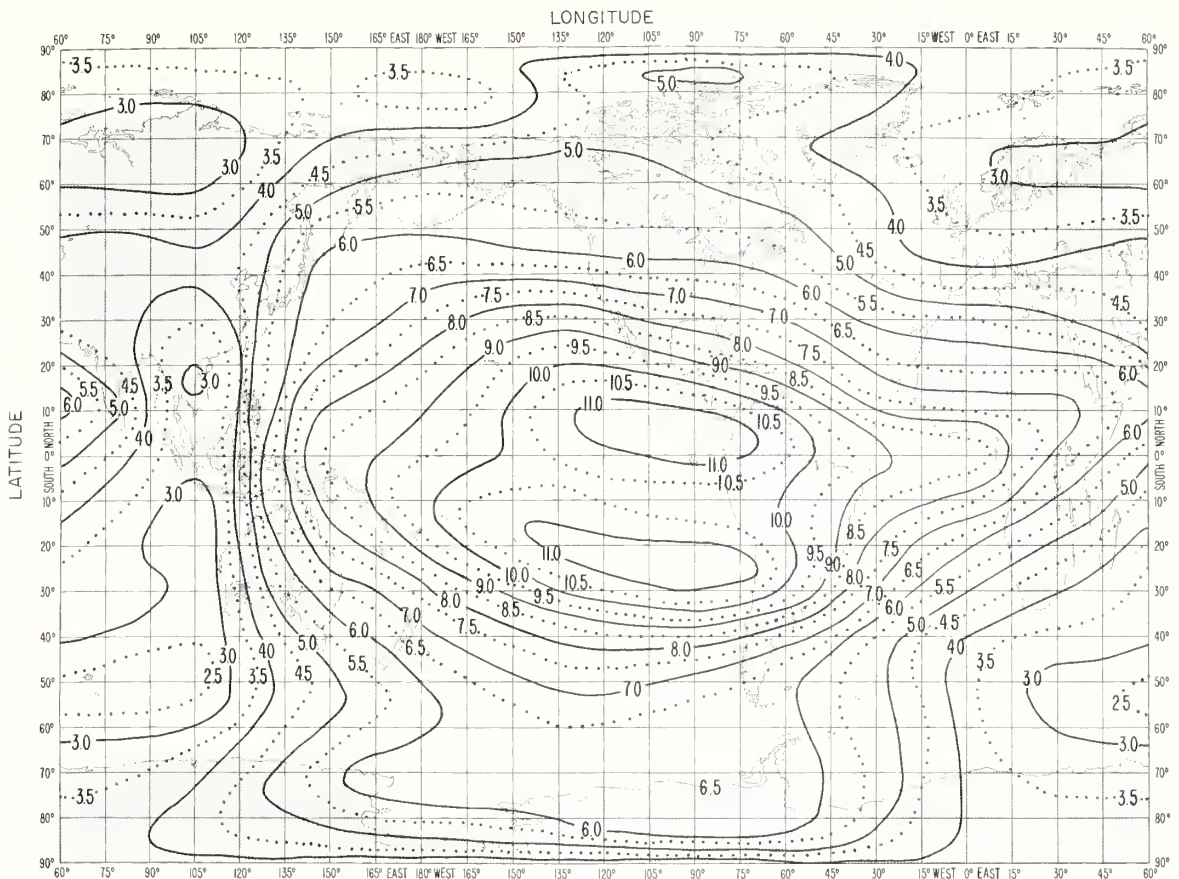


FIG.12A. PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

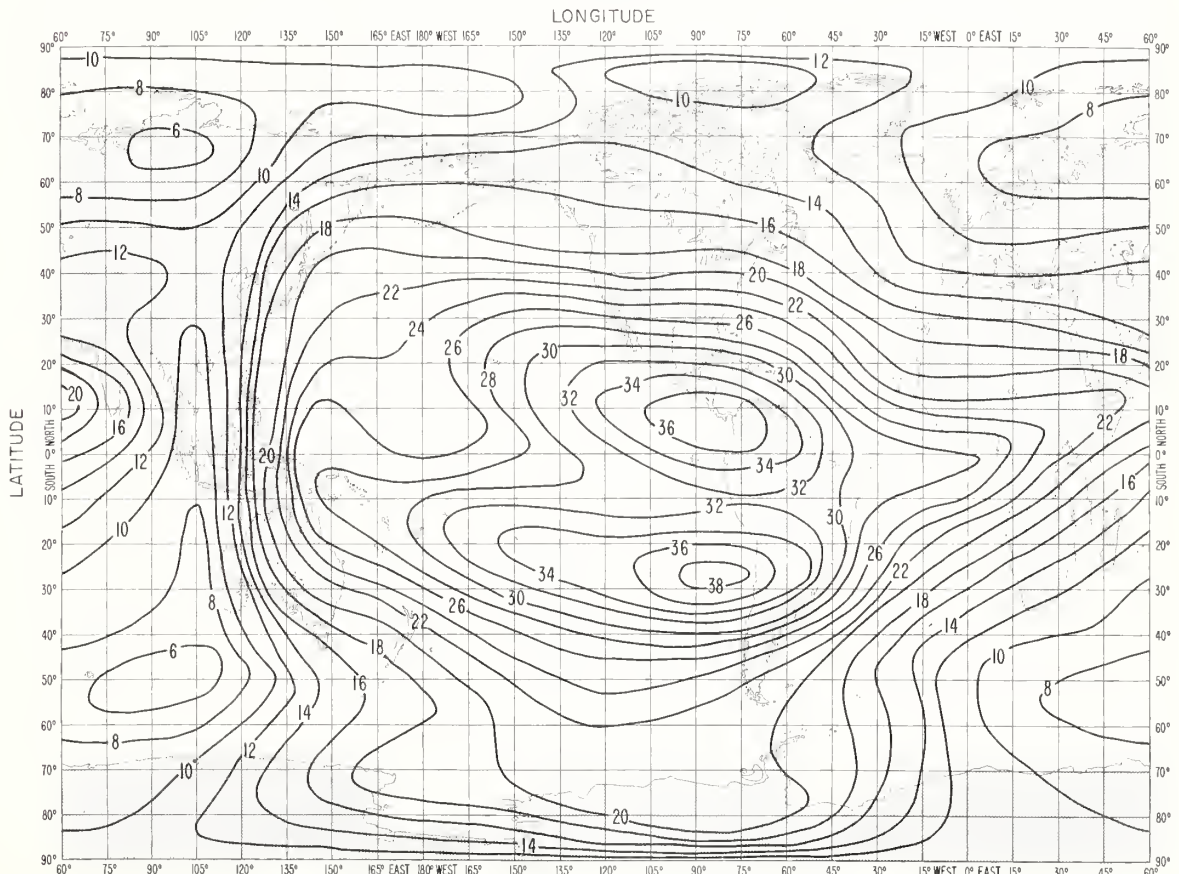


FIG.12B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NORTH POLAR AREA
MARCH 1964 UT = 00

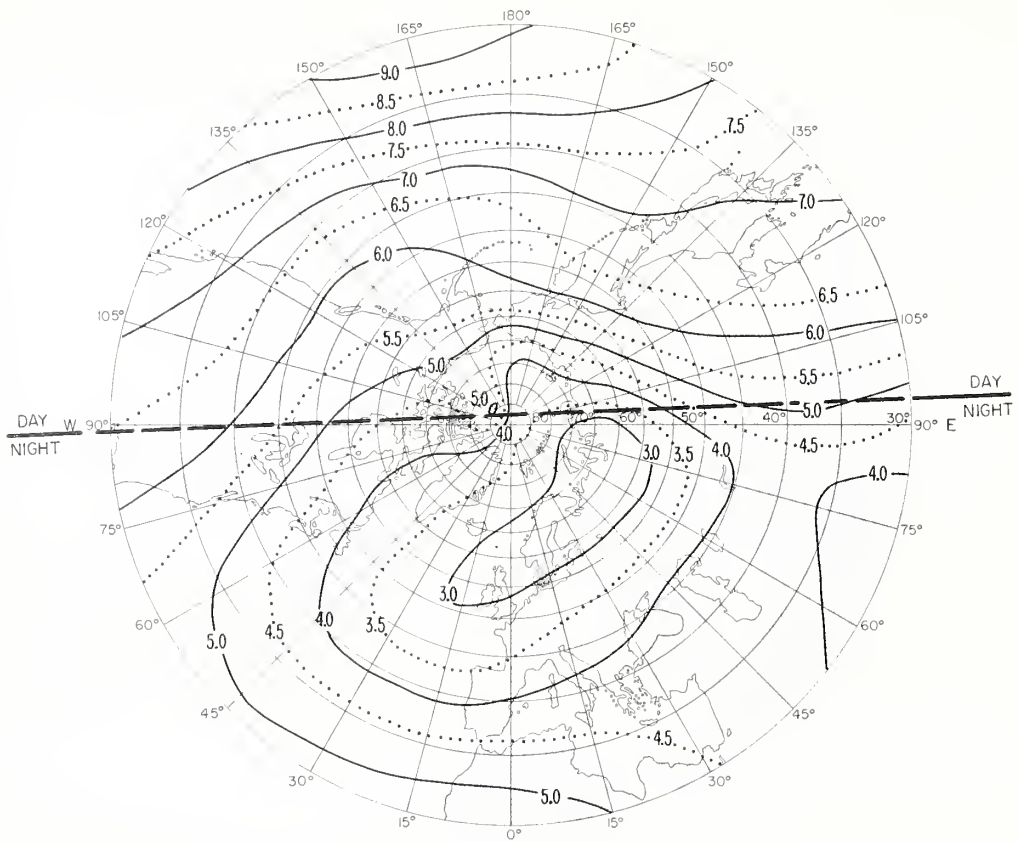


FIG. 13A. PREDICTED MEDIAN MUF (ZERO)F2 (Mc/s)

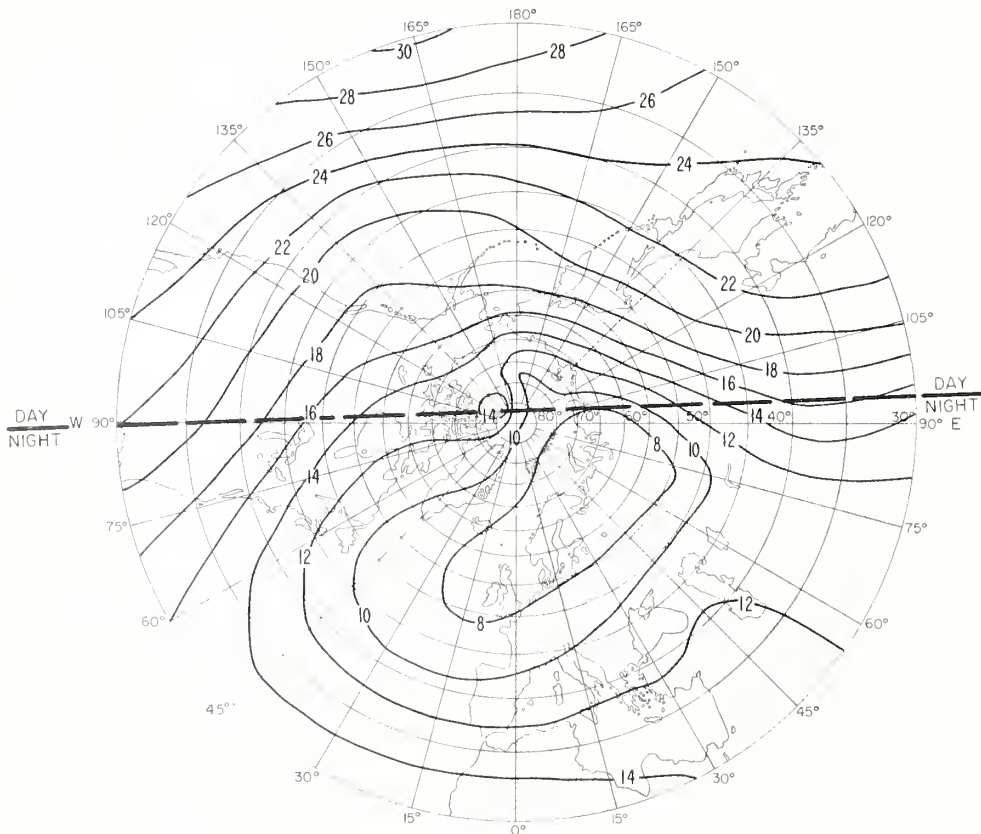


FIG. 13B. PREDICTED MEDIAN MUF (4000)F2 (Mc/s)

SOUTH POLAR AREA
MARCH 1964 UT = 00

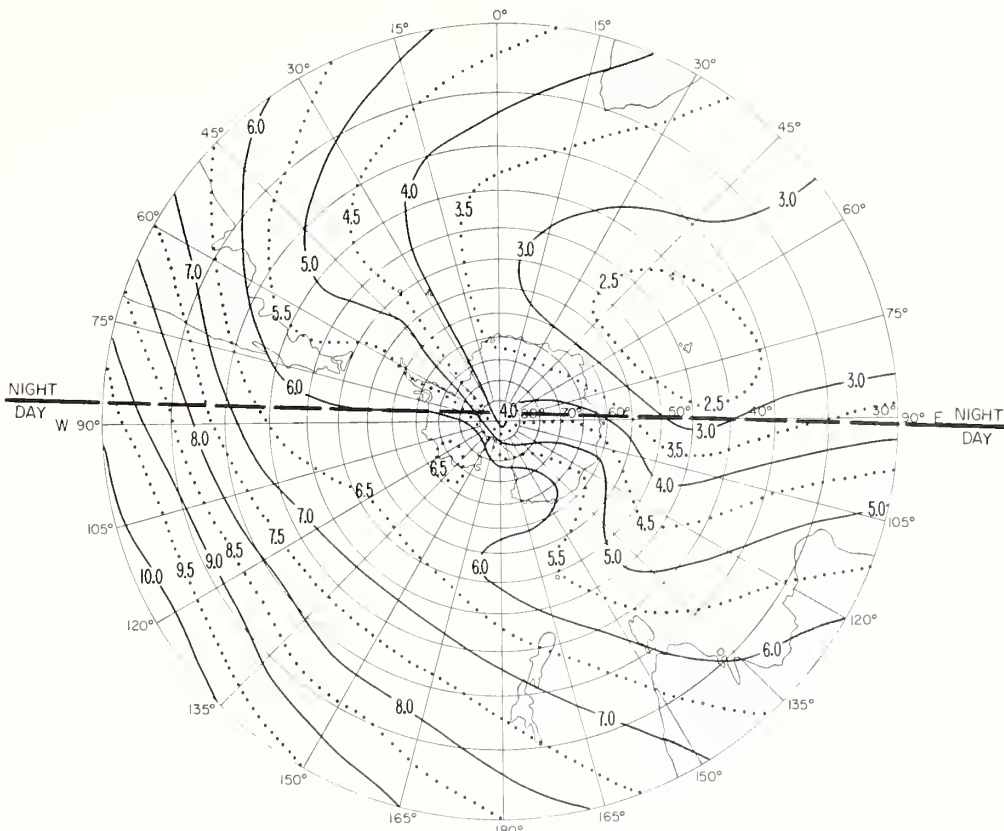


FIG. 14A PREDICTED MEDIAN MUF(0)F2 (Mc/s)

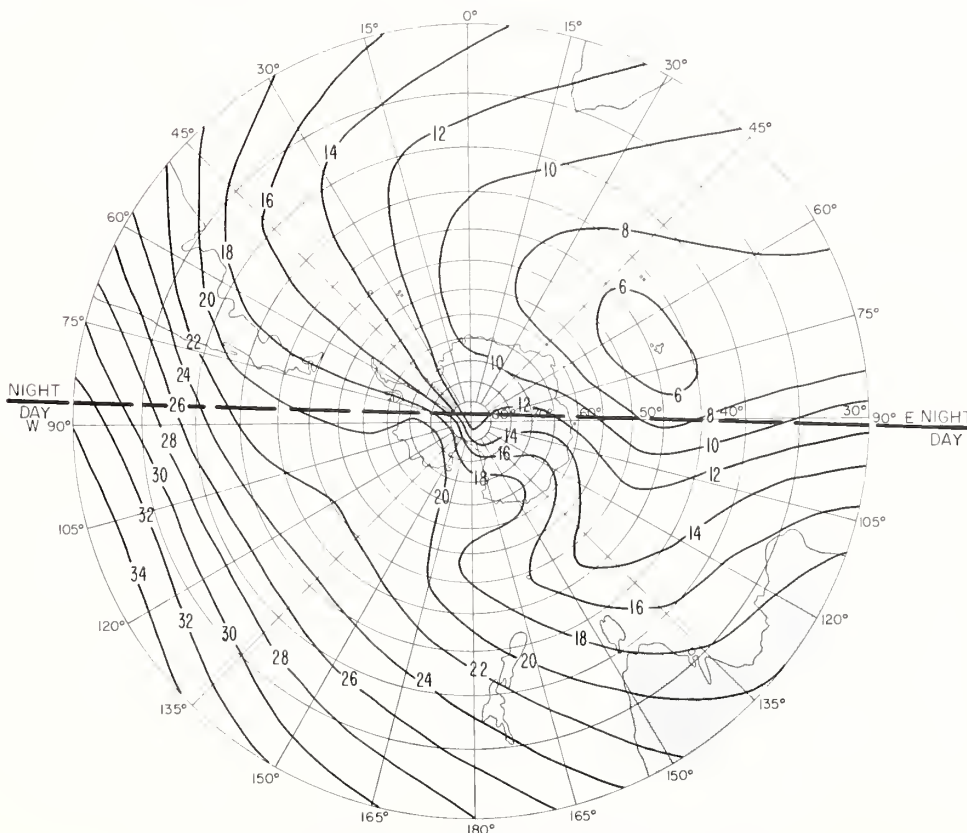


FIG. 14B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

NORTH POLAR AREA
MARCH 1964 UT = 12

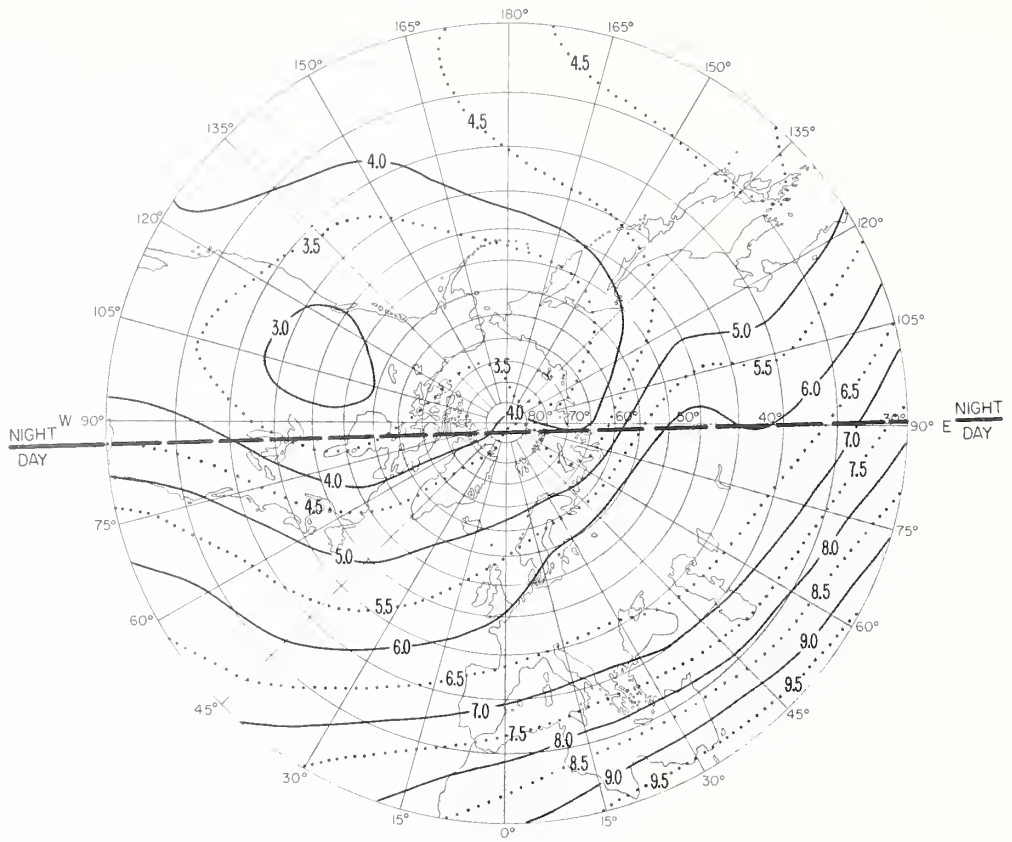


FIG. 15A PREDICTED MEDIAN MUF(ZERO)F2 (Mc/s)

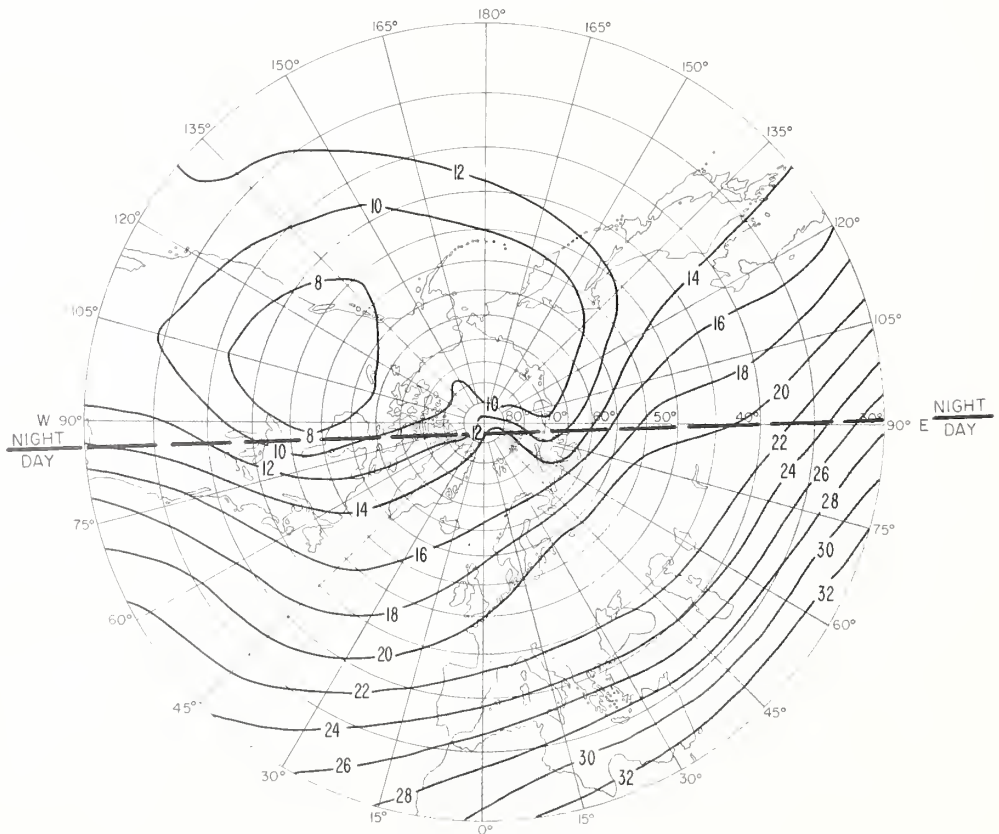


FIG. 15B PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

SOUTH POLAR AREA
MARCH 1964 UT = 12

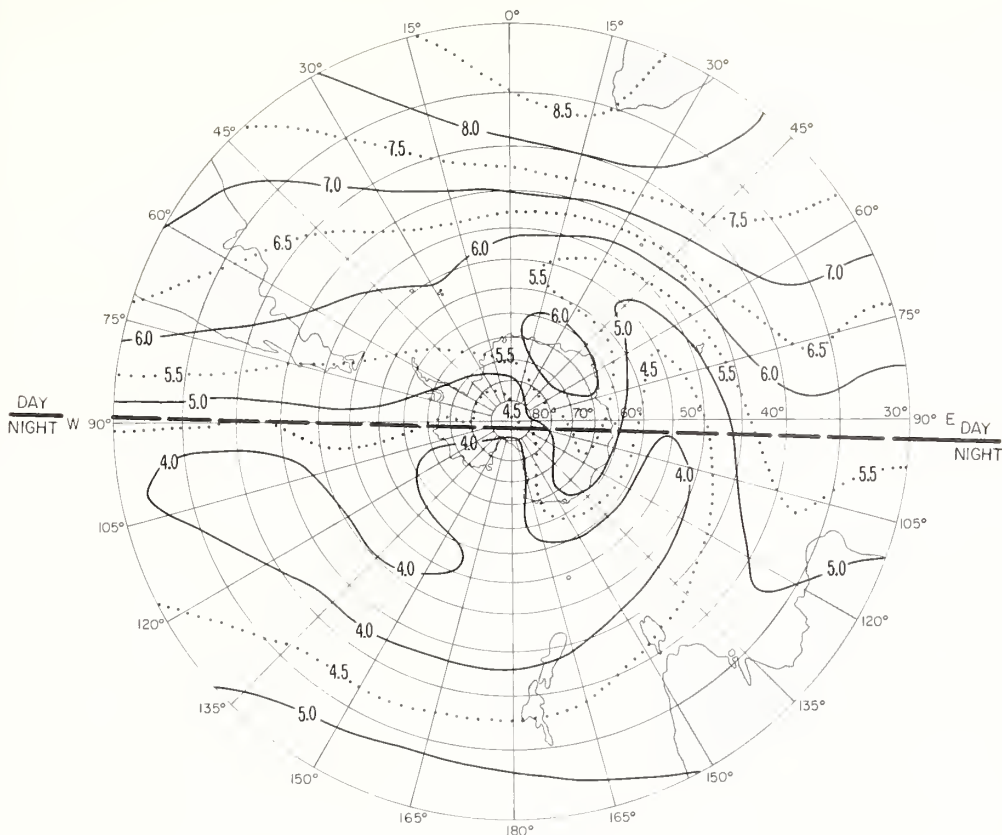


FIG. 16A PREDICTED MEDIAN MUF(0)F2 (Mc/s)

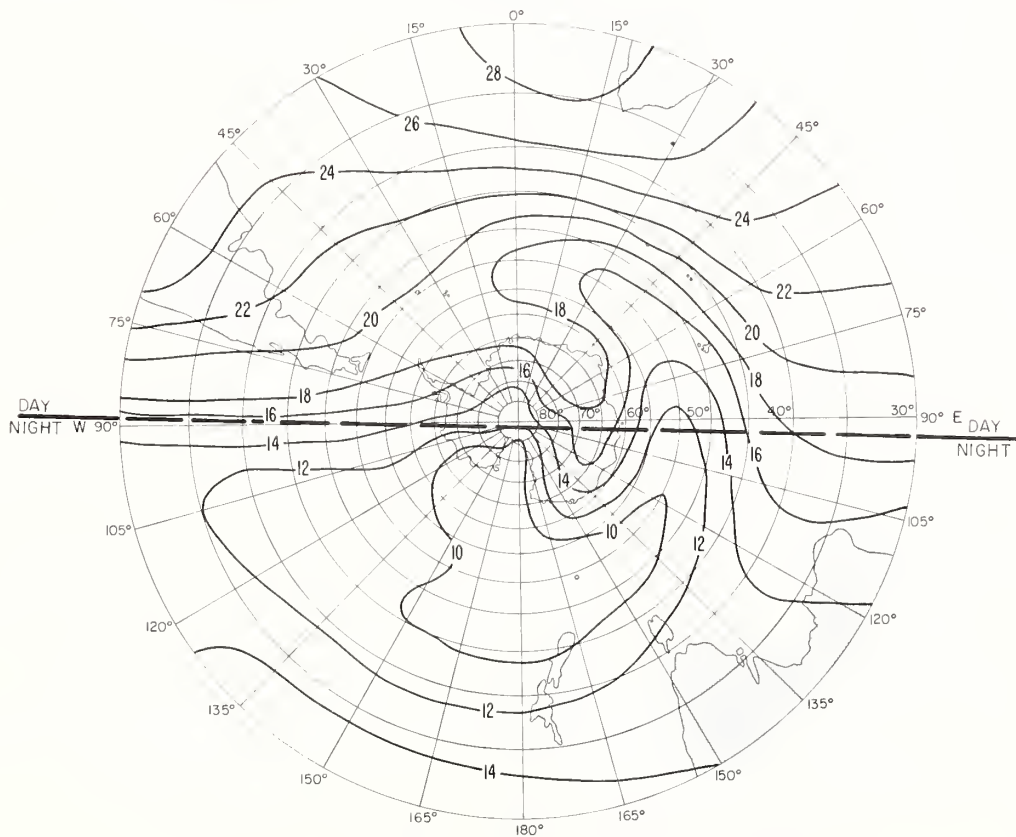


FIG. 16B. PREDICTED MEDIAN MUF(4000)F2 (Mc/s)

HANDBOOK
for
CRPL IONOSPHERIC PREDICTIONS

Based on Numerical Methods of Mapping

NBS Handbook 90 — by S. M. Ostrow — 58 pages — December 1962 — \$0.40

All persons engaged in the solution of high frequency radio propagation problems will need this new *Handbook*, which replaces *Instructions for the Use of Basic Radio Propagation Predictions*, Circular 465 of the National Bureau of Standards.

Beginning with the January 1963 issue, the monthly radio propagation predictions from the Central Radio Propagation Laboratory of the National Bureau of Standards at Boulder, Colorado, will be entitled *CRPL Ionospheric Predictions*, instead of *Basic Radio Propagation Predictions (CRPL-D Series)*, as now called.

CRPL Ionospheric Predictions will fulfill the same functions as its predecessor. However, this new version will be prepared by numerical mapping methods, using an electronic computer. The predictions will be presented in two forms, giving the user the choice of either computer or graphical methods. Those using a computer will derive maximum benefits from the system. However, even when a computer cannot be used, the new prediction maps will provide more information than the earlier zone prediction charts, which were prepared by manual methods and designed primarily for graphical solution of high frequency propagation problems.

Thus the new *Handbook* is a necessity. All users of the *CRPL Ionospheric Predictions* should discard the now-obsolete *Instructions* and obtain a copy of the *Handbook*.

Use the order form below. Please order promptly so that you will have your *Handbook* by the time the January issue of *Predictions* arrives.

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C., 20402

Enclosed find \$_____ in check ☐ money order ☐ for which please send _____ copies of NBS Handbook 90, *Handbook for CRPL Ionospheric Predictions* to:

Name _____

Organization _____

Address _____

City _____ Zone _____ State (or Country) _____

(Please Note: Remittances from foreign countries should be by international money order or by draft on a U.S. bank.)



THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title.

WASHINGTON, D. C.

Electricity. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage. Absolute Electrical Measurements.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Volume.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics.

Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Polymers. Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

Metallurgy. Engineering Metallurgy. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition.

Inorganic Solids. Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics. Operations Research.

Data Processing Systems. Components and Techniques. Computer Technology. Measurements Automation. Engineering Applications. Systems Analysis.

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Far Ultraviolet Physics. Solid State Physics. Electron Physics. Atomic Physics. Plasma Spectroscopy.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Elementary Processes. Mass Spectrometry. Photochemistry and Radiation Chemistry.

Office of Weights and Measures.

BOULDER, COLO.

CRYOGENIC ENGINEERING LABORATORY

Cryogenic Processes. Cryogenic Properties of Solids. Cryogenic Technical Services. Properties of Cryogenic Fluids.

CENTRAL RADIO PROPAGATION LABORATORY

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

Troposphere and Space Telecommunications. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Spectrum Utilization Research. Radio-Meteorology. Lower Atmosphere Physics.

Radio Systems. Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Frequency Utilization. Modulation Research. Antenna Research. Radiodetermination.

Upper Atmosphere and Space Physics. Upper Atmosphere and Plasma Physics. High Latitude Ionosphere Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. Ionospheric Radio Astronomy.

RADIO STANDARDS LABORATORY

Radio Standards Physics. Frequency and Time Disseminations. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Microwave Physics.

Radio Standards Engineering. High Frequency Electrical Standards. High Frequency Calibration Services. High Frequency Impedance Standards. Microwave Calibration Services. Microwave Circuit Standards. Low Frequency Calibration Services.

Joint Institute for Laboratory Astrophysics-NBS Group (Univ. of Colo.).

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D. C., 20402

OFFICIAL BUSINESS

PENALTY FOR PRIVATE USE TO AVOID
PAYMENT OF POSTAGE. \$300
(GPO)

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
WASHINGTON, D. C., 20301, 1 December 1963

TB 11-499-12/TO 31-3-28, CRLP Ionospheric Predictions for March 1964, published for the use of all concerned.

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

EARLE G. WHEELER,
General, United States Army,
Chief of Staff.

OFFICIAL:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

CURTIS E. LEMAY,
Chief of Staff, United States Air Force.

OFFICIAL:

R. J. PUGH,
Colonel, United States Air Force,
Director of Administrative Services.

DISTRIBUTION:

Active Army:

USASA (4); USA Elet Comd (1); CSigO (1); USA MI Comd (1); USA Test & Eval Comd (1); USACD
Agcy (1); USA Msl Spt Comd (1); USCONARC (3); ARADCOM (2); OS Maj Comd (5); OS Base
Comd (2); Log Comd (2); MDW (1); Armies (5); Corps (2); Div. (2); USA Elet RD Acty (4); Svc
Colleges (4); Br Svc Sch (4) except USASCS (20); USAADCEN (4); ARADCOM Rgn (2); WSMR
(2); USA Elet RD Agcy (4); JBUSMC (12); USA Corps (1); USA Mbl Spt Cen (1); USAEPG (2);
USAMC (1); Units org under fol TOE: 11-18 (1); 11-95 (1); 11-500 (AC) (1).

NG: None.

USAR: None.

For explanation of abbreviations used, see AR 320-50.